7.0 DISCUSSION

This study included a wide variety of potential influences to water quality, ranging from relatively undisturbed areas, to highly managed water systems. The study area drained large areas of high elevation watershed, up to 11,750 feet at Leavitt Peak near Carson Pass, where much of the flow was generated from snowmelt. Upper watershed sites were chosen to provide background or source water characteristics for the study area. Additional sites were then located progressively downstream in the main stem channels, below major inflows and land use changes, to include urban, grazing, and irrigated agriculture.

In the following sections, data is analyzed against various backgrounds, including: spatial and temporal changes as water moves downstream through various land uses evaluated both between the sub-watersheds and for the Northeast Basin as a whole, as well as assessed against water quality objectives and goals.

For the figures presented to discuss spatial and temporal analysis and effects of impoundments, the first figure shows the minimum, maximum and 1st and 3rd quartiles for the parameters for each site, moving downstream while the second figure shows actual data points collected during the course of the study as compared to time and season.

Figures used to discuss the Northeast Basin as a whole are summaries similar to summaries used in the spatial, temporal, and impoundment analysis. However, the sites are arranged based on what the site was chosen to represent: upper watershed; impoundments (lakes); releases from impoundments; and lower integrator sites.

7.1 Individual Watersheds

Spatial variability had the greatest impact on the river basin sites where upstream sites (elevation 600 – 3470 feet) primarily received drainage from areas dominated by native vegetation, typically forested areas mixed with chaparral and rolling grassland. Some sites receive runoff from rural foothill communities. The lower watershed areas (from 18 feet elevation to 580 feet elevation) transition from native barren and vacant areas (open lands, flood control, etc.) to areas dominated by agricultural uses. Some major cities, such as Lodi and Stockton provide runoff to lower watershed areas.

<u>Temperature</u>

Temperature in the Cosumnes watershed remained somewhat consistent throughout the watershed, as can be seen in Figure 7. However, in the Mokelumne and Calaveras Watersheds, temperatures increased moving downstream, as shown in Figures 8 and 9. Also, in both the Calaveras and Mokelumne Watersheds, sites immediately downstream from reservoirs – Mokelumne River @ Van Assen Park (SJC512) in the Mokelumne Watershed and Calaveras River @ Monte Vista Trailhead (CAL008) in the Calaveras Watershed - had the least variation in temperature range and averages similar to the upper watershed sites.

Generally, temperature in all three watersheds followed the same trend of being low in the winter months and high in summer months, as shown in Figures 10 - 12.

Dissolved Oxygen

Moving from upper watershed to lower watershed, dissolved oxygen displayed a slight decrease in concentration. This is less noticeable in the Cosumnes (Figure 13) Watershed than Mokelumne (Figure 14) and Calaveras Watersheds (Figure 15).

Seasonal oxygen sag during the summer months appears evident for all sites in all three basins, with fairly direct correlation to increasing temperatures. Sites that had dry periods had lower when water was again present, as shown at Cosumnes River @ Twin Cities Road (SAC001) in Figure 16, Sutter Creek (AMA002) in Figure 17, and North Fork Calaveras River @ Gold Strike Road (CAL003) in Figure 12.

pH

The pH concentrations and range of concentrations were the most consistent in the Cosumnes Watershed (Figure 19), including the lake sites. In the Mokelumne and Calaveras Watersheds, the lake sites had higher pH than the river sites (Figures 20 and 21).

In the Cosumnes watershed, pH concentrations follow the same seasonal trends from site to site (see Figure 22). However, in the Mokelumne (Figure 23) and Calaveras (Figure 24) Watersheds, there is more variation. There is some similarity in trends, but the pattern from site to site is not as clear as in the Cosumnes Watershed. Lake sites – Camanche Reservoir @ South Shore (CAL005) in the Mokelumne Watershed and New Hogan Reservoir @ Acorn East Campground (CAL006)/Wrinkle Cove (CAL007) in the Calaveras Watershed - and the sites immediately below the lakes – Mokelumne River @ Van Assen Park SJC512 and Calaveras River @ Monte Vista Trailhead (CAL008) - shared the same patterns, with the lake sites having higher pH.

Also in the Cosumnes Watershed, all sites experienced a dramatic drop in pH on 22 January, 2002. Data collected at Cosumnes River @ Twin Cities Road through the long term SWAMP drainage basin monitoring indicates this sudden drop in pH is a common occurrence. Data collected in this study suggest extreme changes in pH at Cosumnes River @ Twin Cities are the result of more intense changes upstream of this site (see the first five sampling events in Figure 22). Sites in both the Mokelumne and Calaveras Watersheds also experienced drops, however not as low as in the Cosumnes Watershed sites.

Electrical Conductivity

Electrical conductivity in the Cosumnes Watershed moving from upstream to downstream increased both in concentration and range (Figure 25). However, in the Mokelumne and Calaveras Watersheds, upper watershed sites had a greater range than lower watershed sites (Figures 26 and 27). Sites immediately downstream from reservoirs had a tighter range in concentration than the other river sites. Lake Amador (AMA003) in the Mokelumne Watershed (Figure 26) also had a higher concentration than most of the watershed. The Calaveras Watershed electrical conductivity concentrations and range of concentrations were higher than the other two watersheds, especially in the upper watershed main forks.

Similar to dissolved oxygen, sites that had dry seasons affected electrical conductivity. These sites generally had higher concentrations and range of concentrations than sites that had year round flows, and once the stream flowed again, the concentration tended to be elevated from the previous concentrations - see Cosumnes River @ Twin Cities Road (SAC001) in Figure 28, Sutter Creek (AMA002) in Figure 29, and N. Fork Calaveras @ Gold Strike Road (CAL003) in Figure 30.

Turbidity

Turbidity at lake sites where the lake bottom could be seen and was unlined – Jenkinson Lake @ Pinecone Campsites (ELD001) in Figure 31, Camanche Reservoir @ South Shore (CAL005) in Figure 32, and New Hogan Reservoir @ Acorn East Campground (CAL006) and Wrinkle Cove (CAL007) in Figure 33 - generally had a greater range than river sites. The exception was Cosumnes River @ Twin Cities Road (SAC001) in Figure 31, with a Q1-Q3 range almost five times that of Jenkinson Lake @ Pinecone Campsites (ELD001). Concentrations were low (generally under 10 NTU) at most sites, regardless of location within the watershed (Figures 31-33).

Peak turbidity concentrations in all watersheds occurred in the late fall (Figures 34-36). Most peaks were at lake sites, except one sample recorded at Cosumnes River @ Twin Cities Road (SAC001). These peaks were independent of rain events. The highest peaks occurred in the Cosumnes Watershed.

Total Suspended Solids

The highest maximum total suspended solid concentrations in the Cosumnes and Calaveras Watersheds were recorded at the lake sites (Figures 37 and 39, respectively). The lake sites also contained the highest average concentrations in the two watersheds. The average river site concentrations in the Cosumnes and Mokelumne Watersheds increased moving from upstream to down stream with the highest overall TSS concentration at the downstream most Mokelumne site. In the Calaveras Watershed, the river sites were generally consistent from site to site, with most samples remaining under 5 mg/L.

Spikes occurred in all watersheds in mid February, June, and early September (Figures 40-42), with the most noticeable spikes occurring in lake sites. Spikes in February occurred immediately after a rain events, however June spikes occurred during a period of decreasing flows and no rain, while September spikes occurred during a dry period.

Total Organic Carbon

Generally, TOC in all watersheds was low (Figures 43 through 45), below 8 mg/L. In the Cosumnes Watershed, average concentrations decrease moving downstream except Cosumnes River @ Twin Cities Road (SAC001) at the furthest downstream site, with an average greater than Cosumnes River @ Gold Beach Park (ELD003), the upper most site in the watershed. Upper watershed averages in both the Mokelumne and Calaveras Watersheds was lower than the averages in the lower watershed sites. However, the highest spikes in concentration occurred at the upper watershed sites Sutter Creek (AMA002) in Figure 44 and San Antonio Creek @ Sheep Ranch Road (CAL001) in Figure 45.

A TOC spike in May (Figures 46-48) corresponded with the last rain event of the spring rain season, and the TOC spike in November corresponded with the first rain event of the winter spring season. The most significant spike occurred at Sutter Creek (AMA002), resulting in a concentration of 38 mg/L.

E. coli

Concentrations at some sites fell below the lower reporting limit (<1 MPN/100 mL) and above the upper reporting liming (>2419 MPN/100 mL). To create these figures, values had to be assigned for each of these occurrences. For the purposes of making these figures, samples below the reporting limit were calculated at 0.5 MPN/100mL, and samples above the reporting limit were calculated at 2420 MPN/100mL.

In the Cosumnes and Calaveras Watersheds, the sites in the furthest downstream reach displayed the greatest variation between the 1st and 3rd quartiles in *E. coli* concentration - Figures 49, Cosumnes River @ Twin Cities Road (SAC001), and 51, Calaveras River @ Highway 88 (SJC513). In the upper Mokelumne and Calaveras Watersheds, the sites with the greatest variation – Sutter Creek (AMA002) in Figure 49 and Calaveritas Creek @ Highway 49 (CAL002) in Figure 39 - were those within tributaries to the main stems. Both of these tributaries were ephemeral.

Peak *E. coli* concentrations did not occur at the same time of year for all three watersheds. In the Cosumnes Watershed (Figure 52), peak concentrations occurred in the spring through summer months, with the highest concentrations of 525 MPN/100mL at Cosumnes River @ Gold Beach Park (ELD003), the furthest upstream site, and 549 MPN/100mL at Cosumnes River @ Twin Cities Road (SAC001), the furthest downstream site. Spikes were also seen when flows returned to ephemeral sites - >2419.6 MPN/100mL at Cosumnes River @ Twin Cities Road (SAC001) and 272 MPN/100mL at Cosumnes River @ Michigan Bar Road (SAC003).

In the Mokelumne Watershed (Figure 53), peak concentrations were observed starting in the summer months at Sutter Creek (AMA002), with the maximum concentration at this site being reached in the late fall – early winter months.

In the Calaveras Watershed, peak concentrations were reached at different times of the year for each site. At Calaveras River @ Highway 88 (SJC513), *E. coli* concentration was highest in the early spring, reaching a maximum above the detection level. This site again had sporadic high concentrations through the summer months. Peak concentrations at Calaveritas Creek @ Highway 49 (CAL002) and North Fork Calaveras River @ Gold Strike Road (CAL003) were reached in mid spring. Calaveritas Creek @ Highway 49 (CAL002) again had high concentrations in early summer and late fall. Concentrations at Calaveritas Creek @ Highway 49 (CAL002) was highest in the fall, after flows returned after a drying period. Peak concentration at San Antonio Creek @ Sheep Ranch Road (CAL001) was reached in early winter in a sample collected after a precipitation event.

Spatial and Temporal Trends Summary
Many constituents displayed variations due to seasonal changes that were consistent with multiple interactions. For instance, temperature at all sites increased during the summer months regardless of flow and land use, as well as increased moving from upstream to downstream. Conversely, dissolved oxygen decreased at all sites during the warmer summer months. Other constituents, such as electrical conductivity, TOC, and *E. coli* were seasonally influenced particularly by storm events. The magnitude of the influence increased dramatically if the site experienced a dry period. The pH was variable throughout the year, regardless of season or location in the watershed.

Factors other than location in the watershed may have more influence on water quality than location in the watershed. Some of these factors are discussed in section 9.2 Comparison of Upper Watershed, Impoundments, Releases from Impoundments, and Lower Integrator sites.

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Figure 7 Summary Temperature: Cosumnes Watershed, January - December 2002

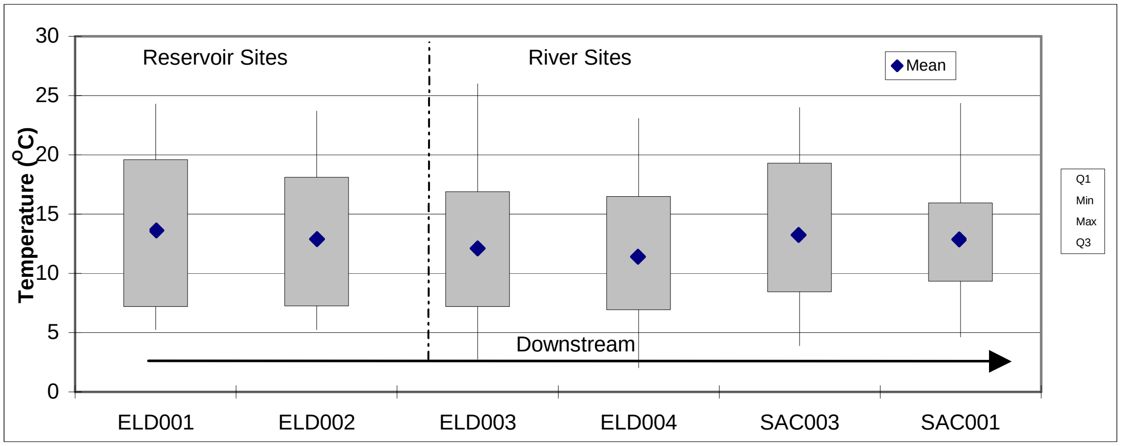


Figure 8 Summary Temperature: Mokelumne Watershed, January - December 2002

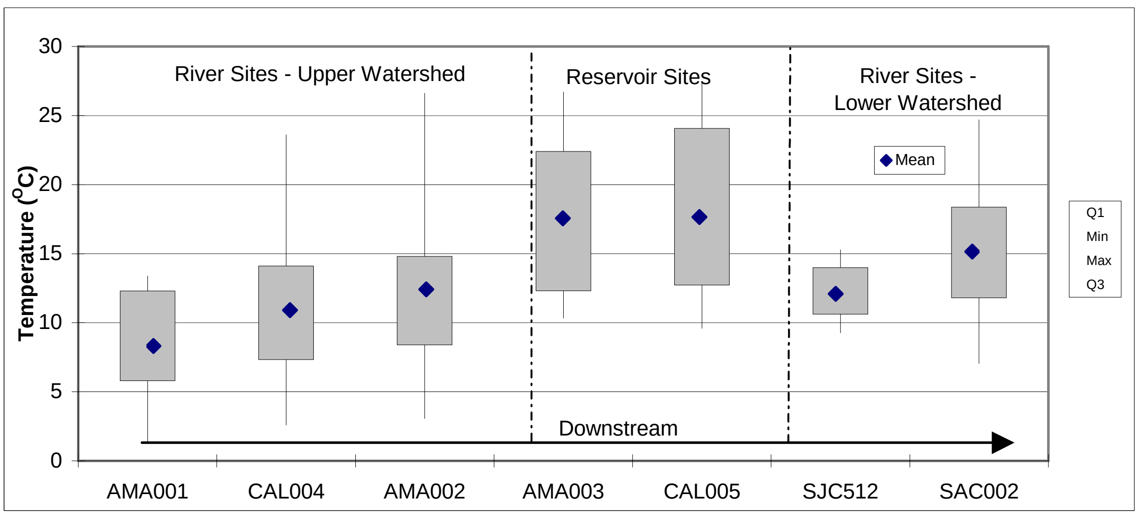


Figure 9 Summary Temperature: Calaveras Watershed, January - December 2002

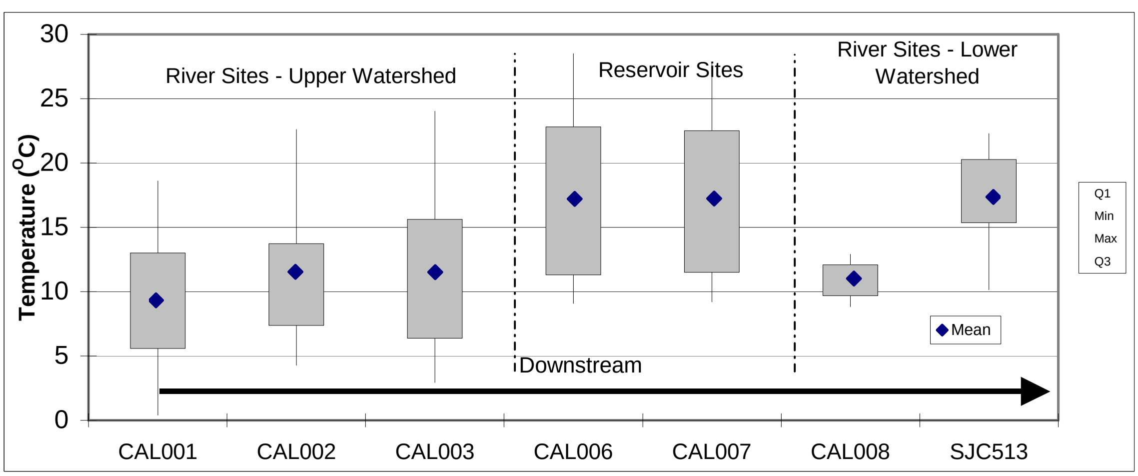


Figure 10 Biweekly Temperature: Cosumnes Watershed, January - December 2002

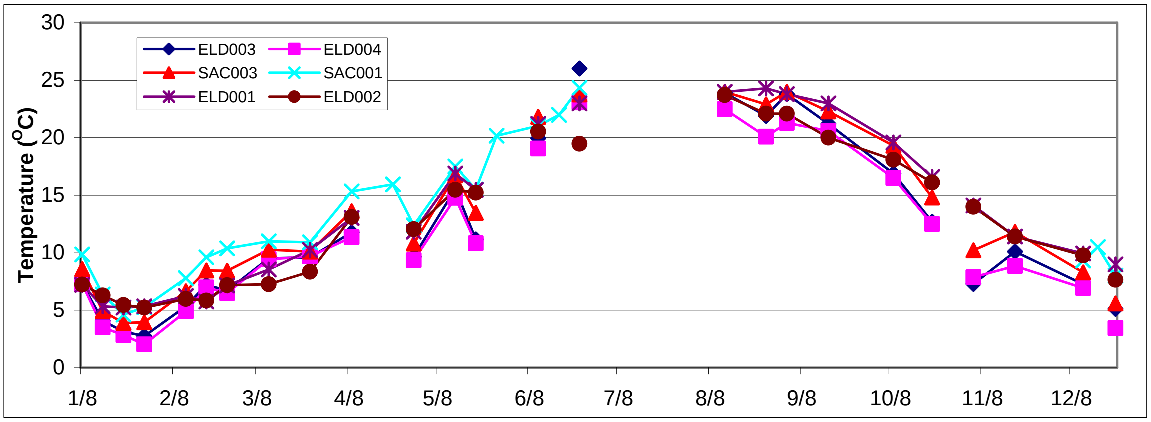


Figure 11 Biweekly Temperature: Mokelumne Watershed, January - December 2002

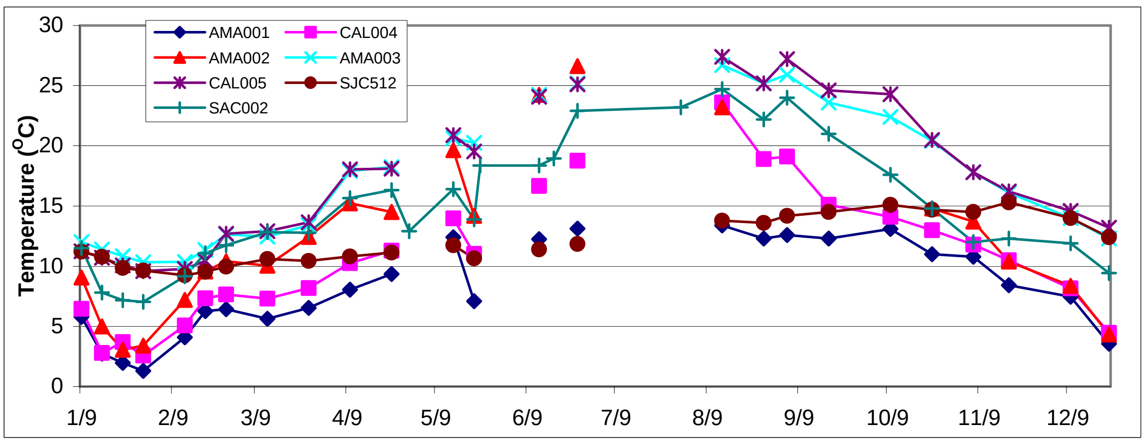


Figure 12 Biweekly Temperature: Calaveras Watershed, January - December 2002

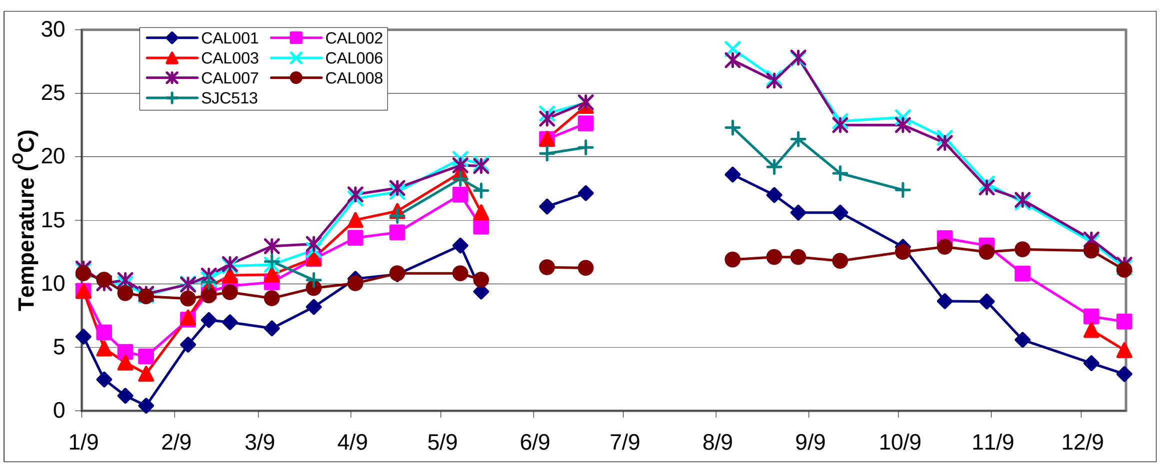


Figure 13 Summary Dissolved Oxygen: Cosumnes Watershed, January - December 2002

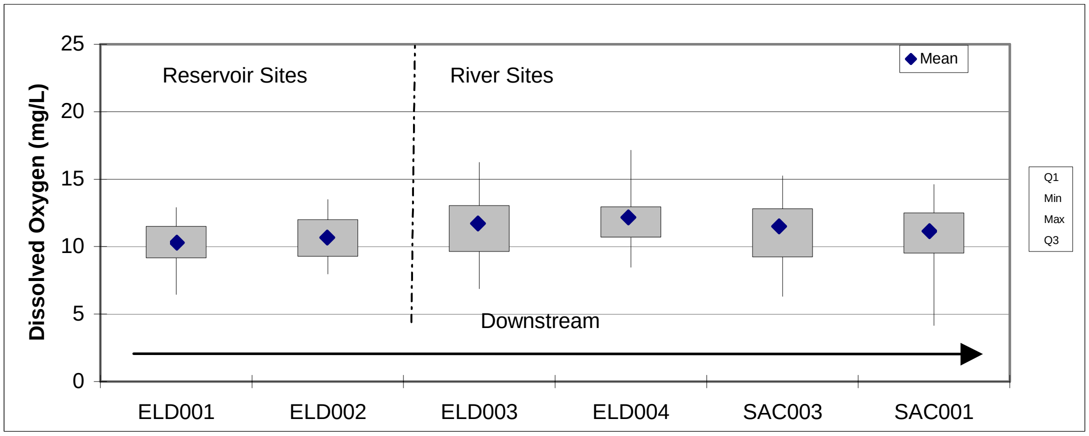


Figure 14 Summary Dissolved Oxygen: Mokelumne Watershed, January - December 2002

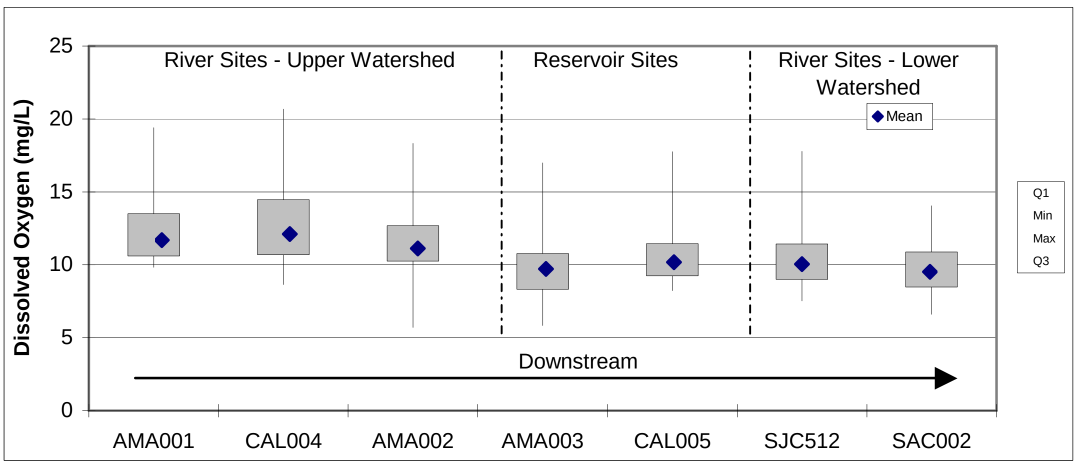


Figure 15 Summary Dissolved Oxygen: Calaveras Watershed, January - December 2002

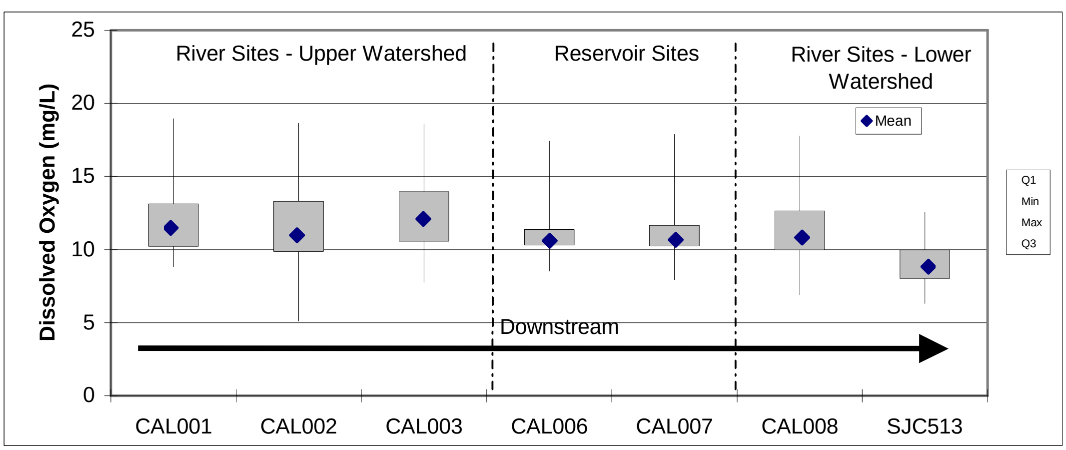


Figure 16 Biweekly Dissolved Oxygen: Cosumnes Watershed, January - December 2002

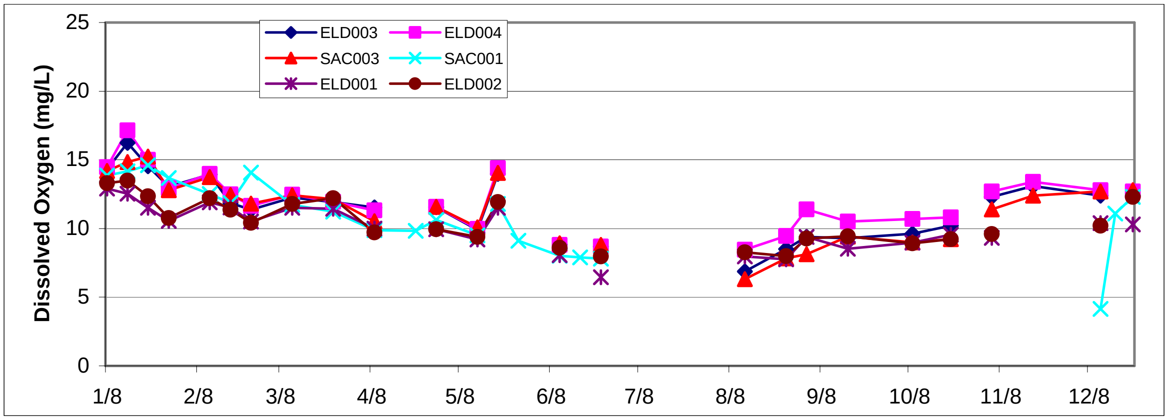


Figure 17 Biweekly Dissolved Oxygen: Mokelumne Watershed, January - December 2002

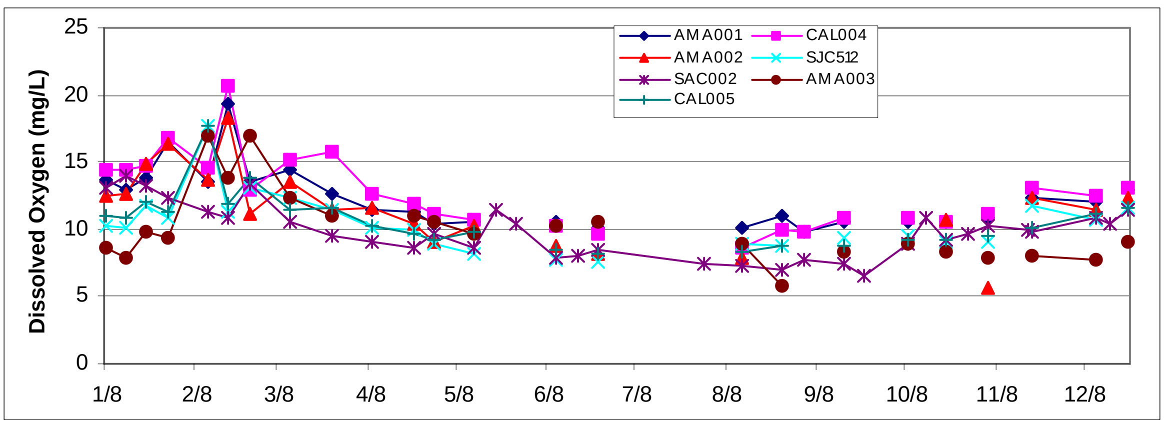


Figure 18 Biweekly Dissolved Oxygen: Calaveras Watershed, January - December 2002

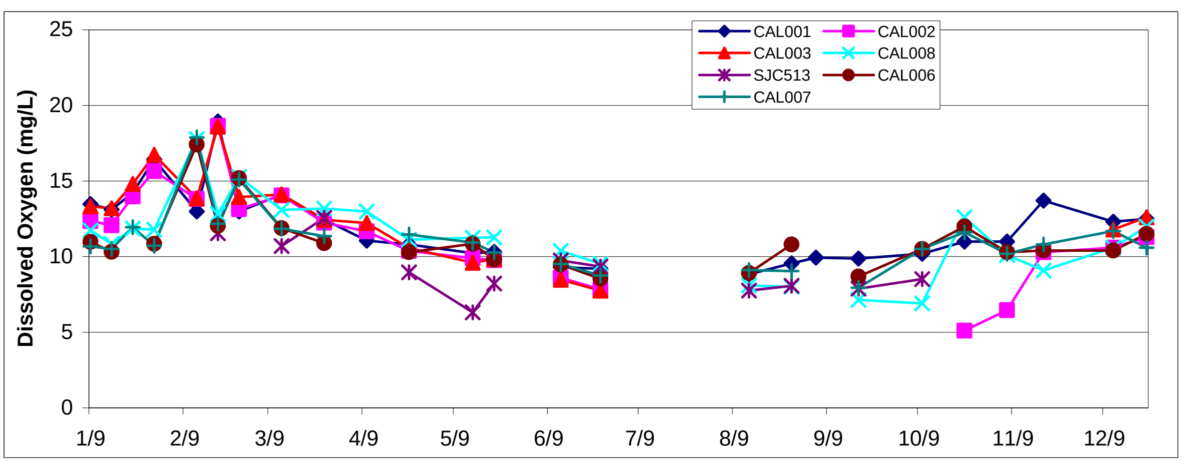


Figure 19 Summary pH: Cosumnes Watershed, January - December 2002

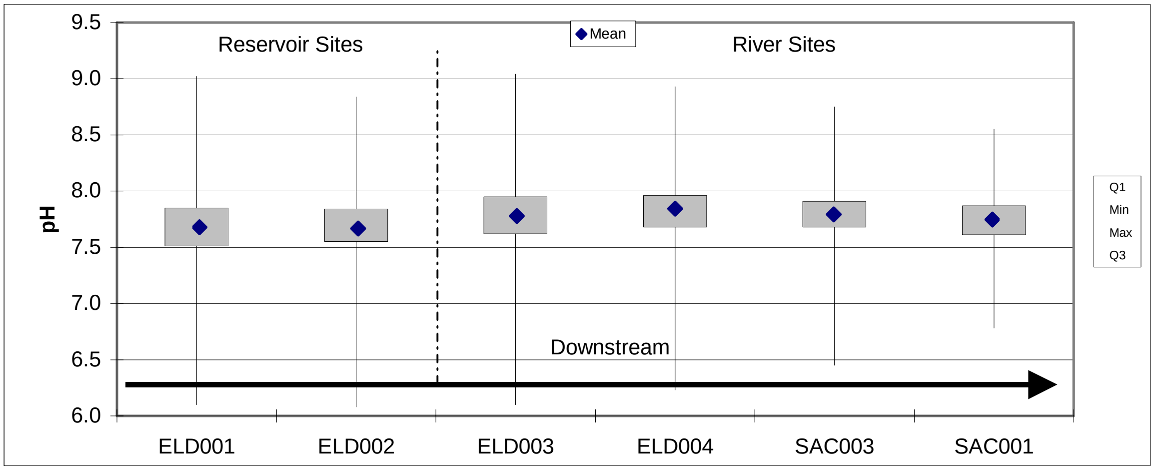


Figure 20 Summary pH: Mokelumne Watershed, January - December 2002

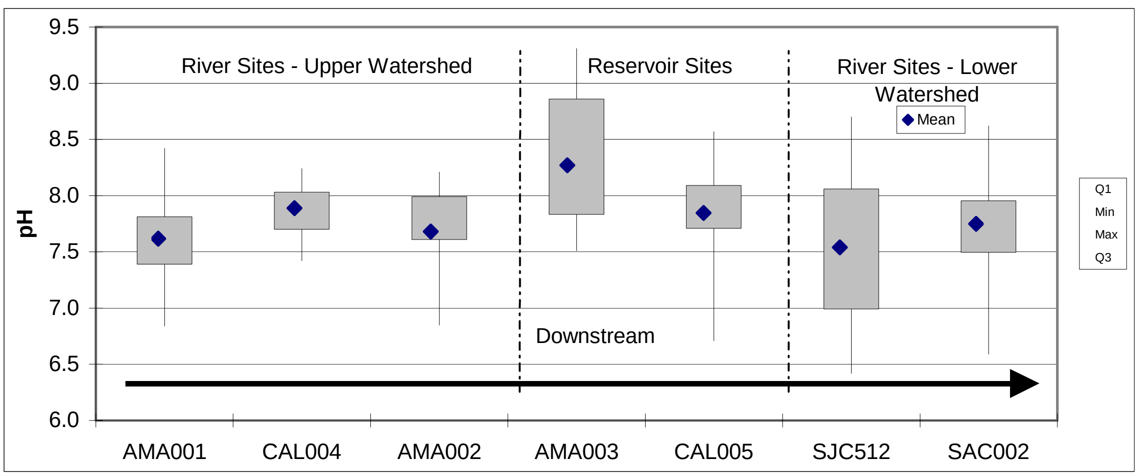


Figure 21 Summary pH: Calaveras Watershed, January - December 2002

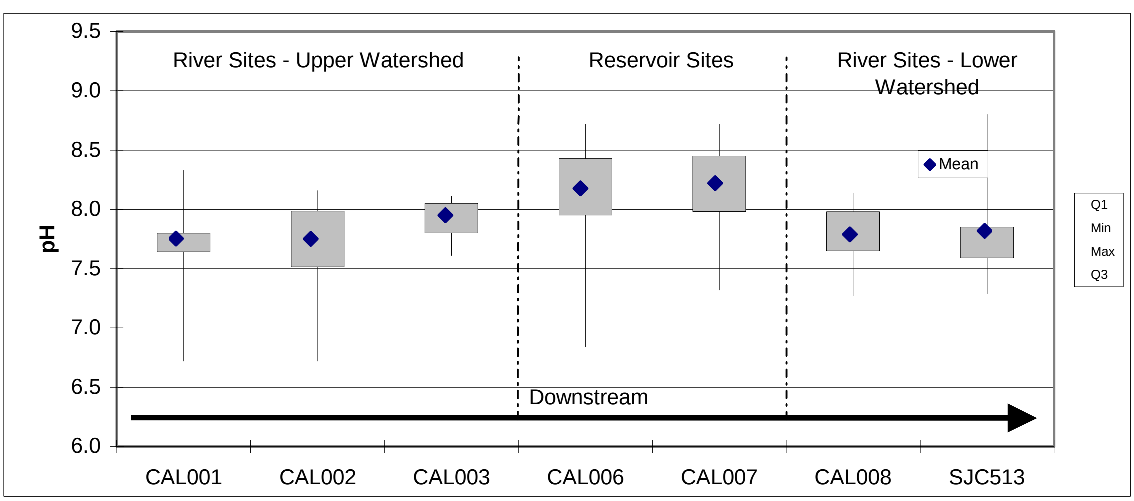


Figure 22 Biweekly pH: Cosumnes Watershed, January - December 2002

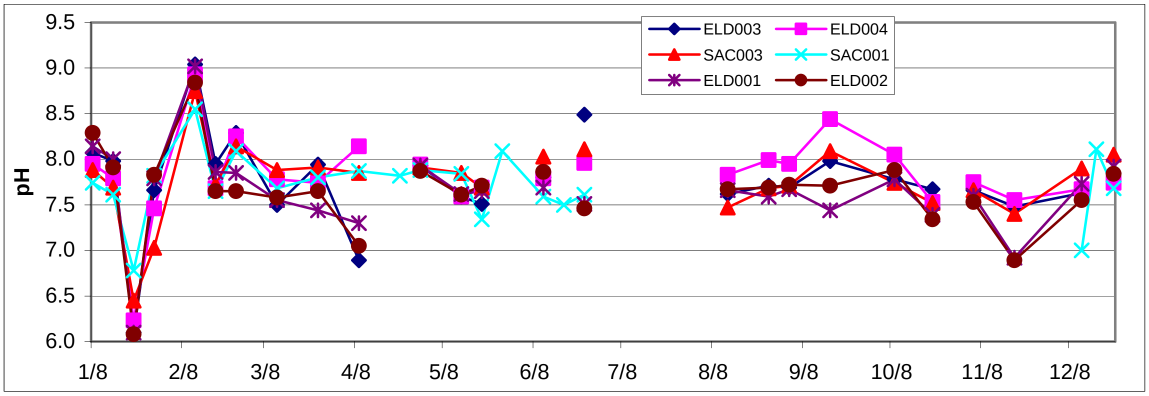


Figure 23 Biweekly pH: Mokelumne Watershed, January - December 2002

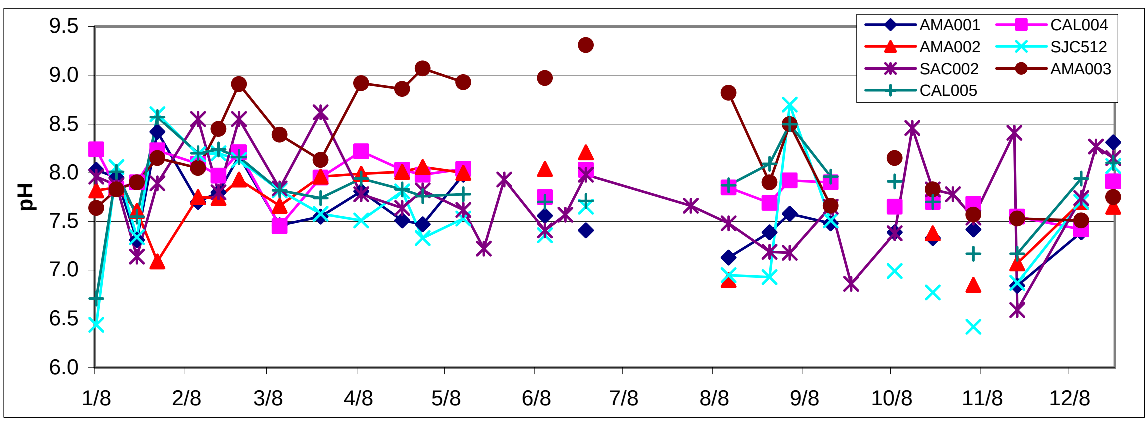


Figure 24 Biweekly pH: Calaveras Watershed, January - December 2002

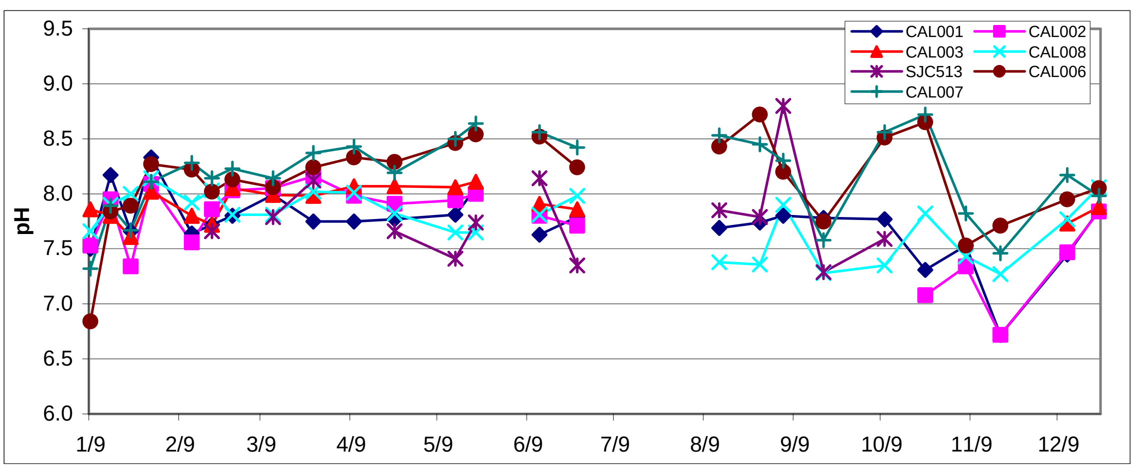


Figure 25 Summary Electrical Conductivity: Cosumnes Watershed, January - December 2002

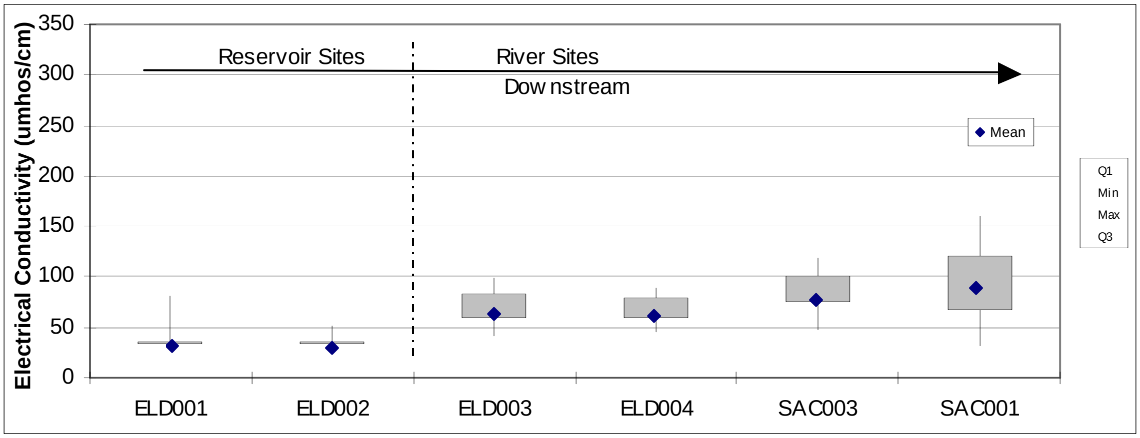


Figure 26 Summary Electrical Conductivity: Mokelumne Watershed, January - December 2002

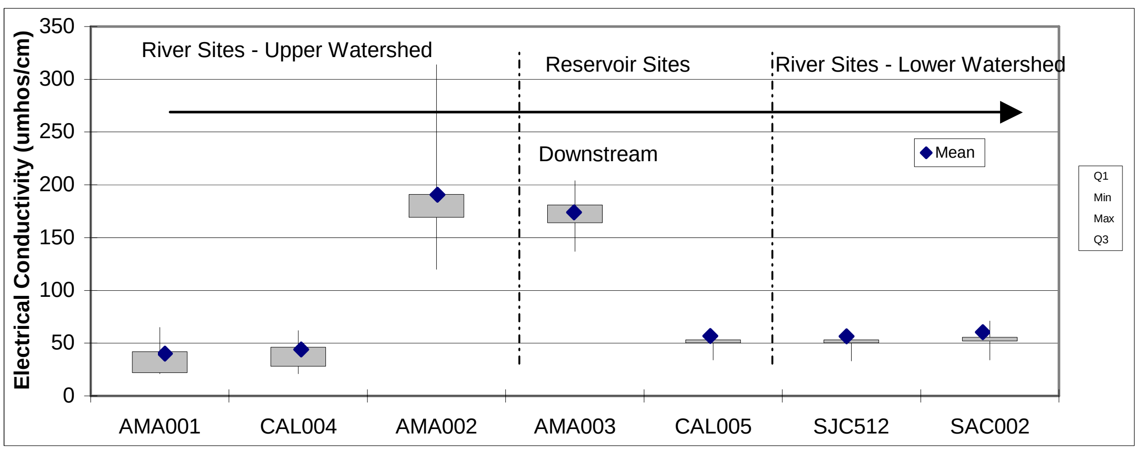


Figure 27 Summary Electrical Conductivity: Calaveras Watershed, January - December 2002

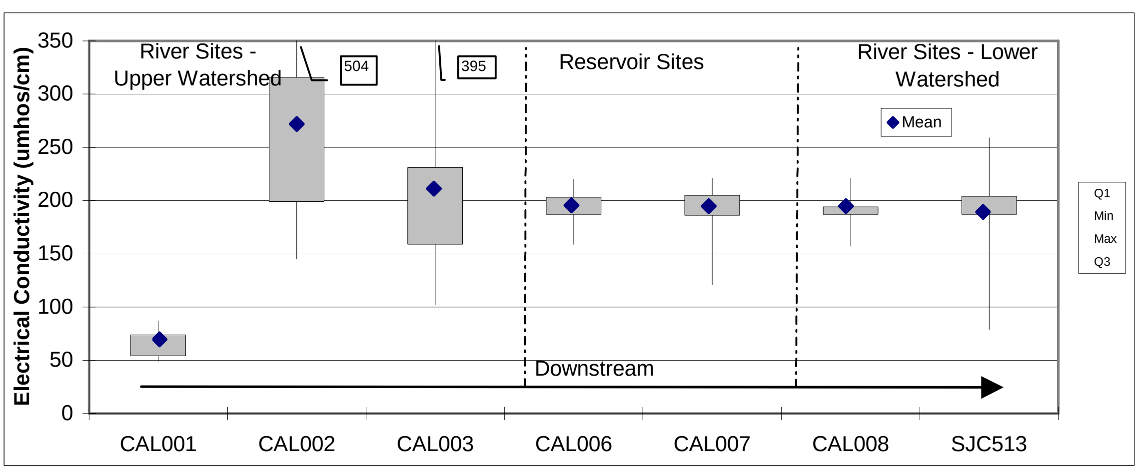


Figure 28 Biweekly Electrical Conductivity: Cosumnes Watershed, January - December 2002

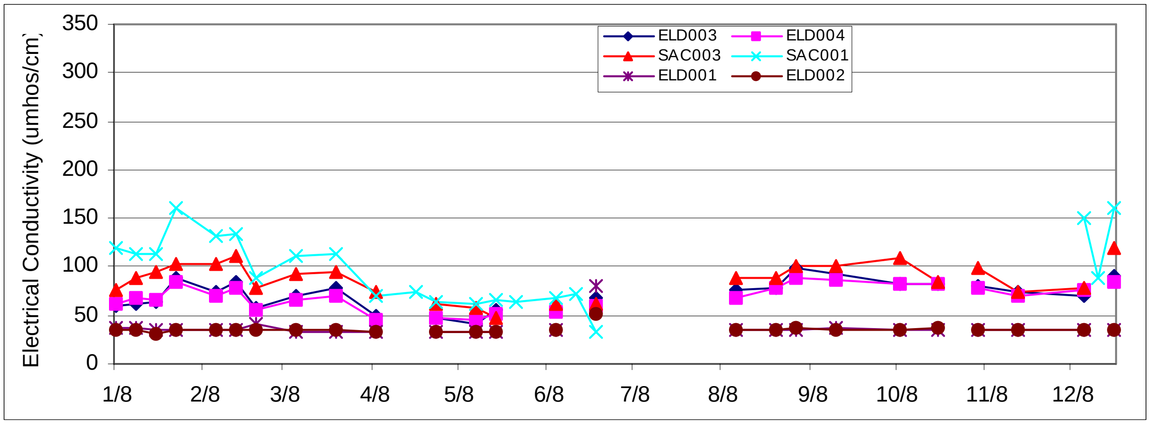


Figure 29 Biweekly Electrical Conductivity: Mokelumne Watershed, January - December 2002

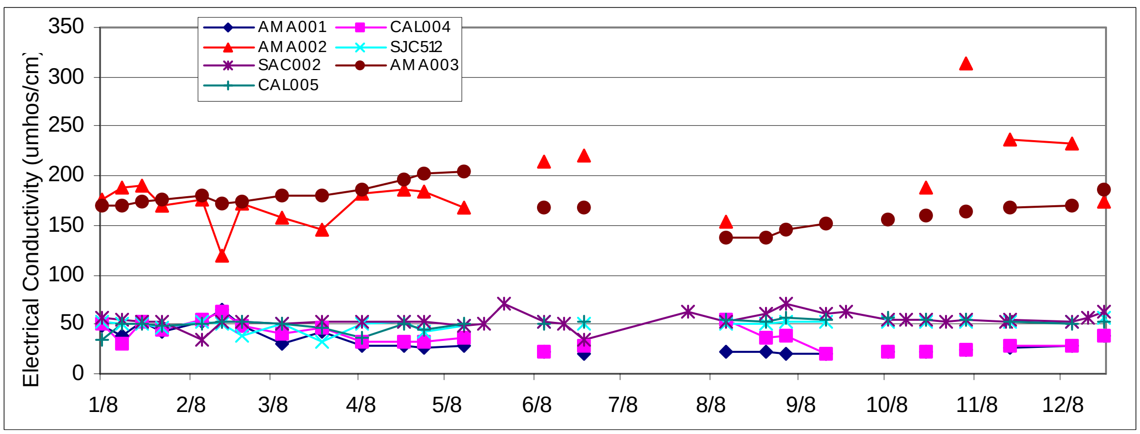


Figure 30 Biweekly Electrical Conductivity: Calaveras Watershed, January - December 2002

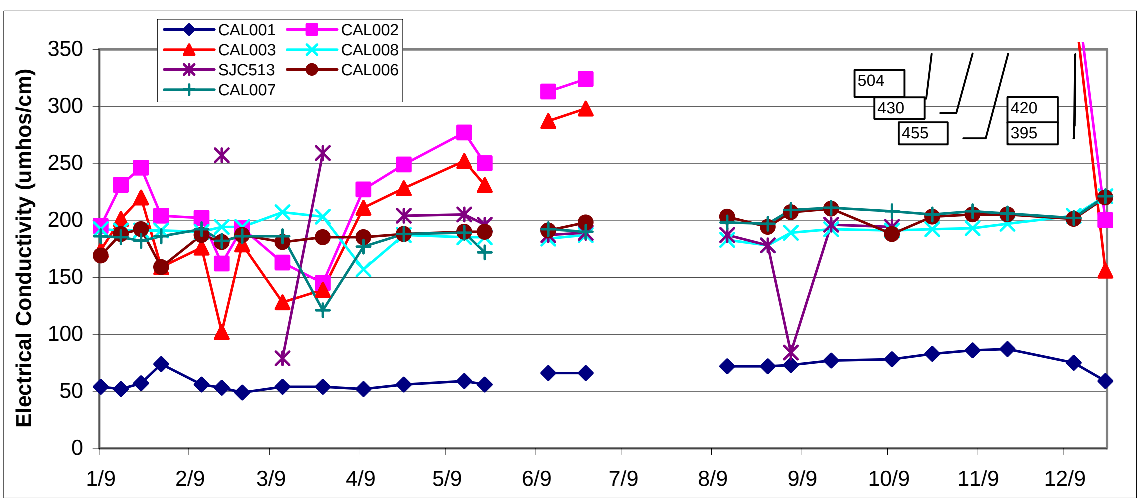


Figure 31 Summary Turbidity: Cosumnes Watershed, January - December 2002

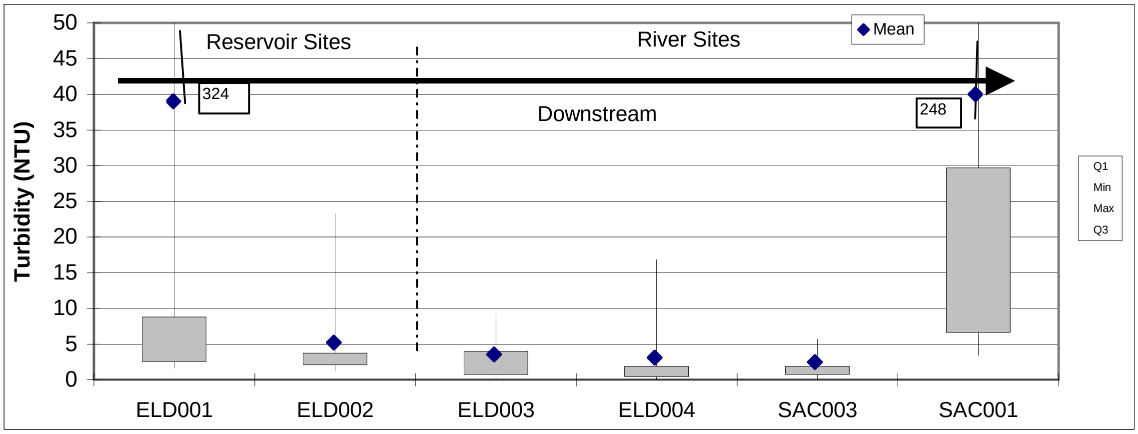


Figure 32 Summary Turbidity: Mokelumne Watershed, January - December 2002

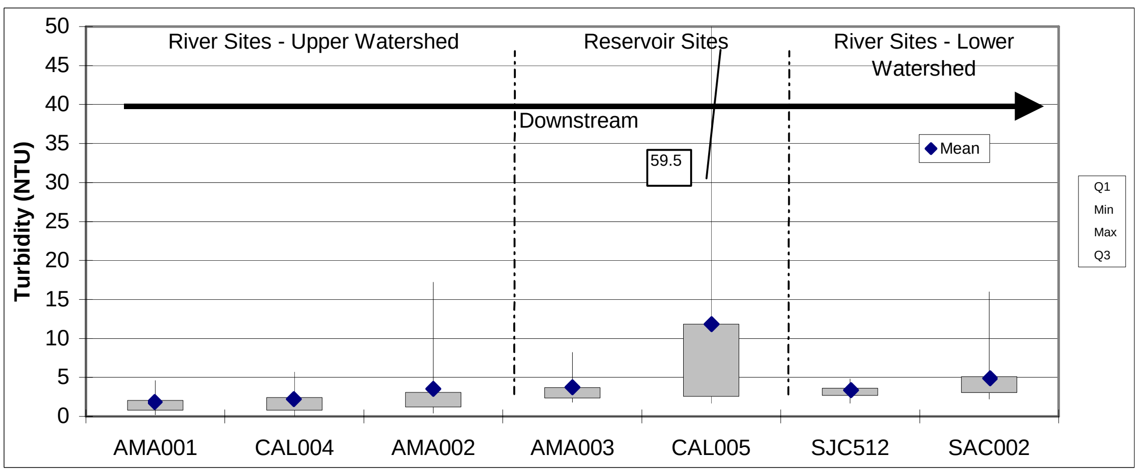


Figure 33 Summary Turbidity: Calaveras Watershed, January - December 2002

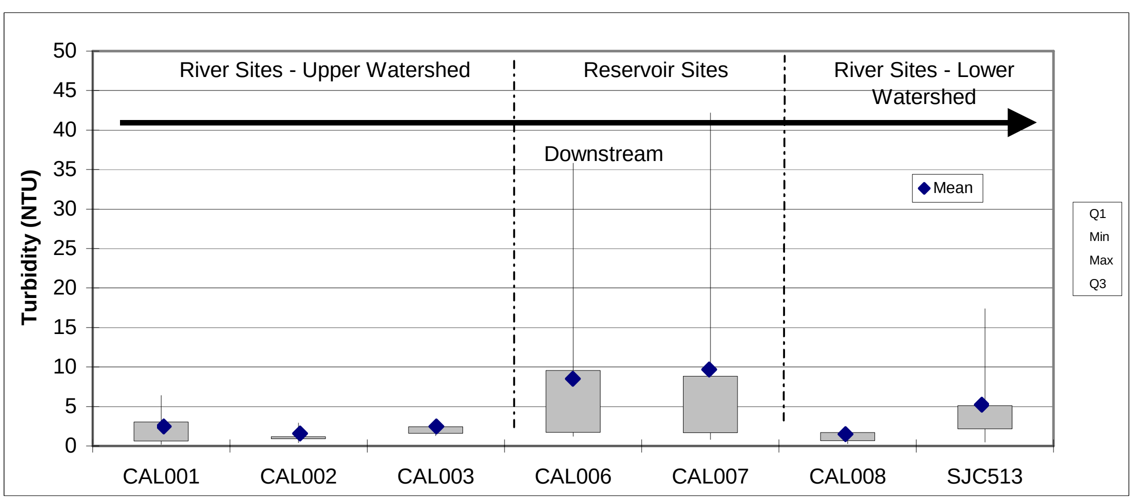


Figure 34 Biweekly Turbidity: Cosumnes Watershed, January - December 2002

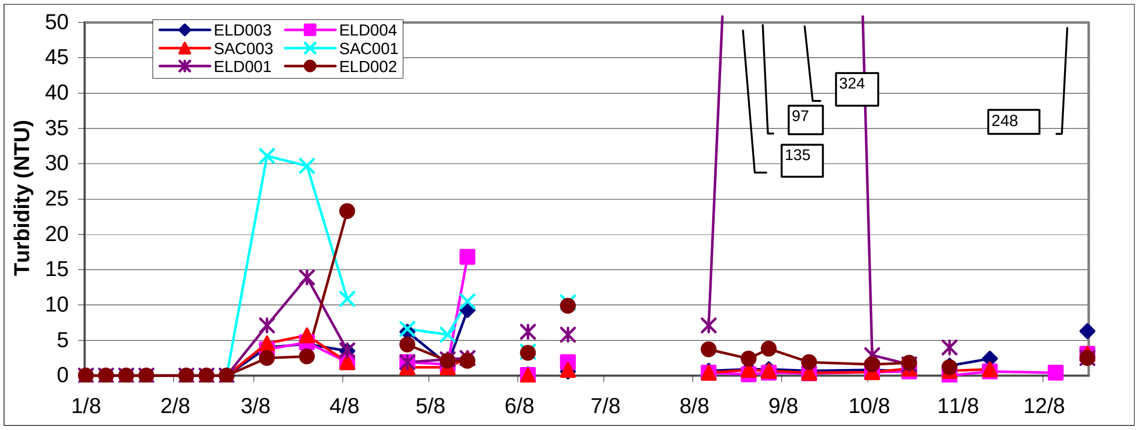


Figure 35 Biweekly Turbidity: Mokelumne Watershed, January - December 2002

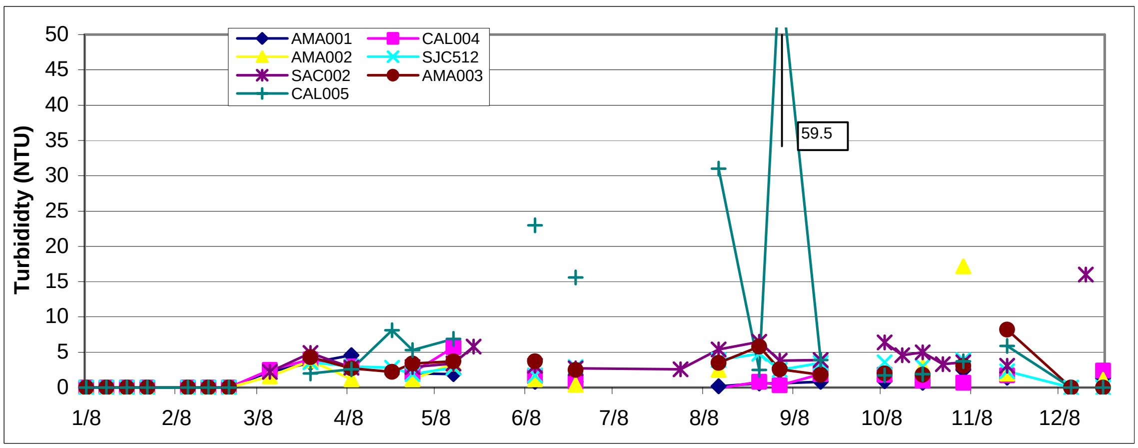


Figure 36 Biweekly Turbidity: Calaveras Watershed, January - December 2002

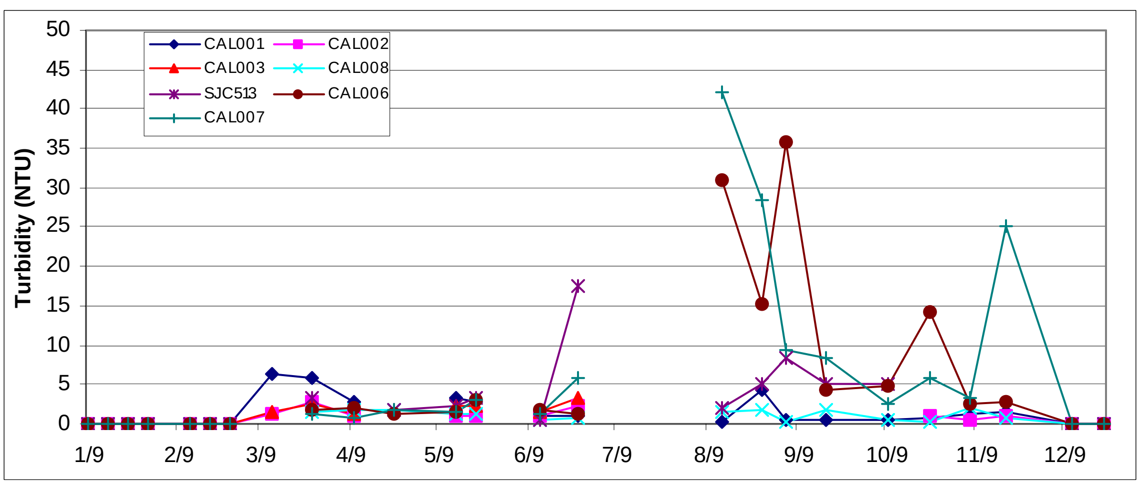


Figure 37 Summary Total Suspended Solids: Cosumnes Watershed, January - December 2002

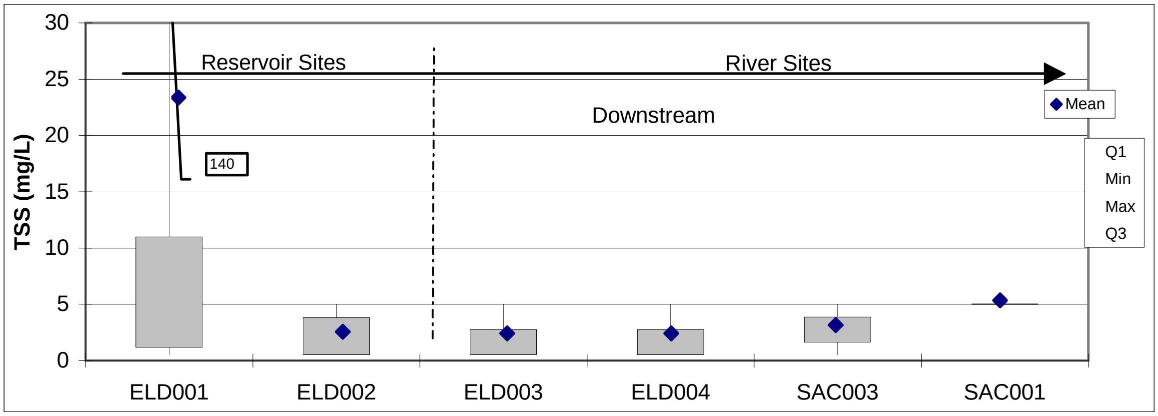


Figure 38 Summary Total Suspended Solids: Mokelumne Watershed, January - December 2002

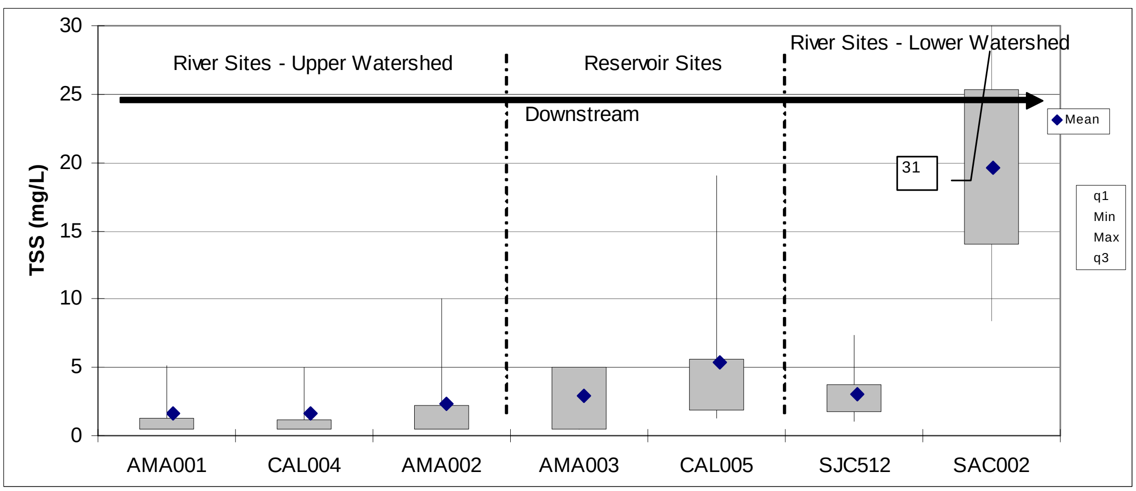


Figure 39 Summary Total Suspended Solids: Calaveras Watershed, January - December 2002

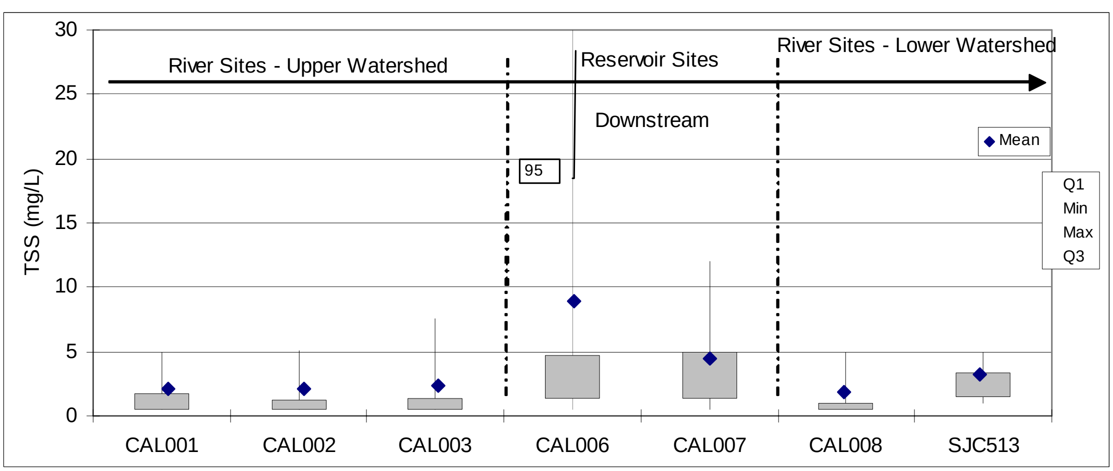


Figure 40 Biweekly Total Suspended Solids: Cosumnes Watershed, January - December 2002

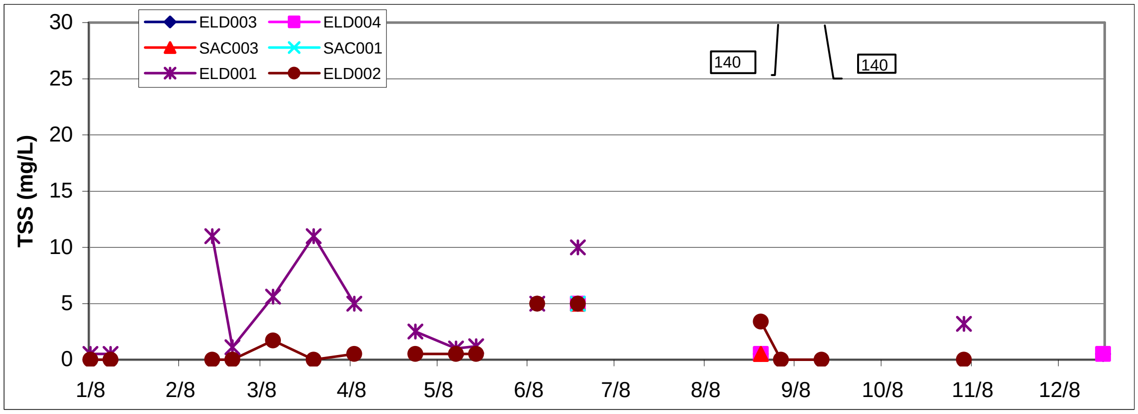


Figure 41 Biweekly Total Suspended Solids: Mokelumne Watershed, January - December 2002

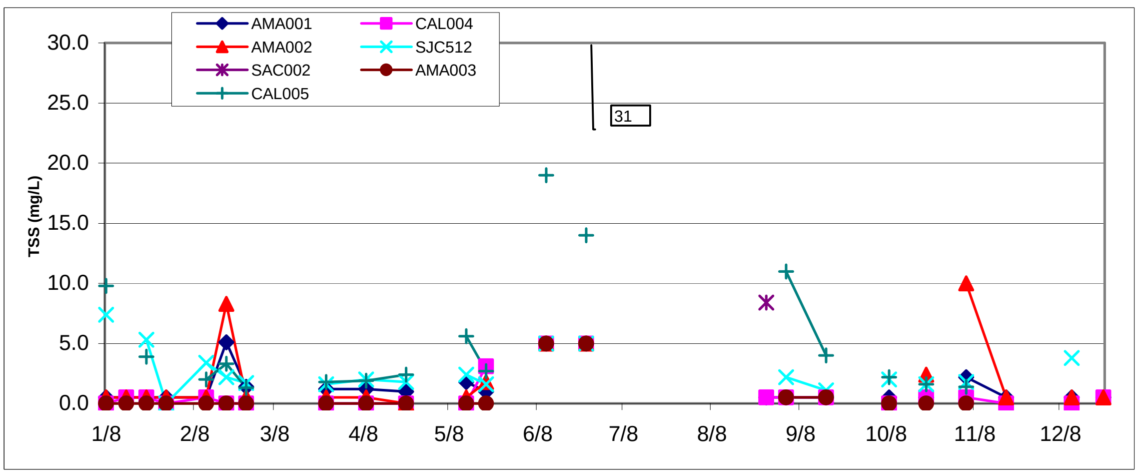


Figure 42 Biweekly Total Suspended Solids: Calaveras Watershed, January - December 2002

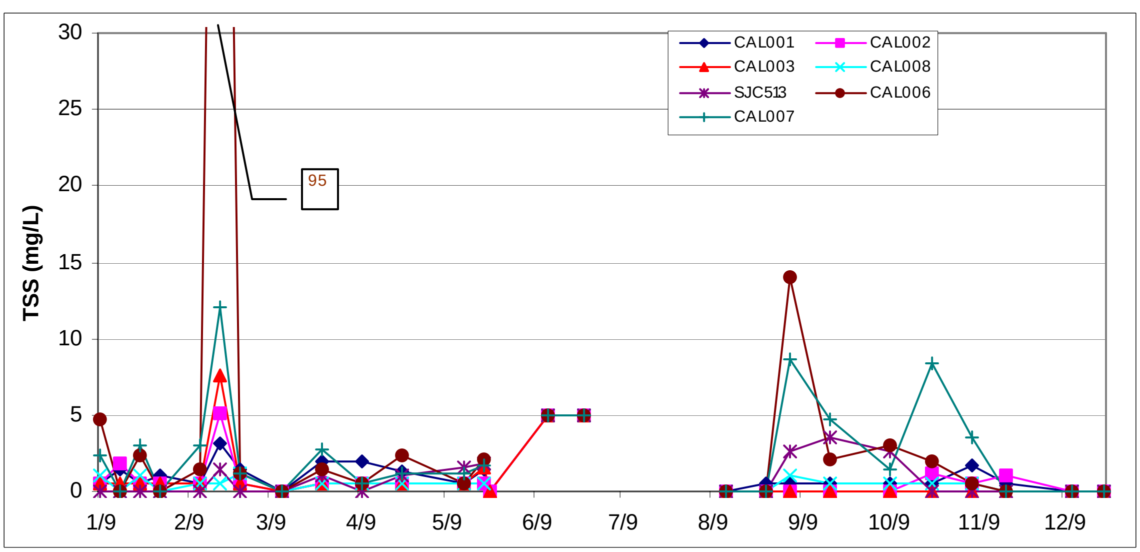


Figure 43 Summary Total Organic Carbon: Cosumnes Watershed, January - December 2002

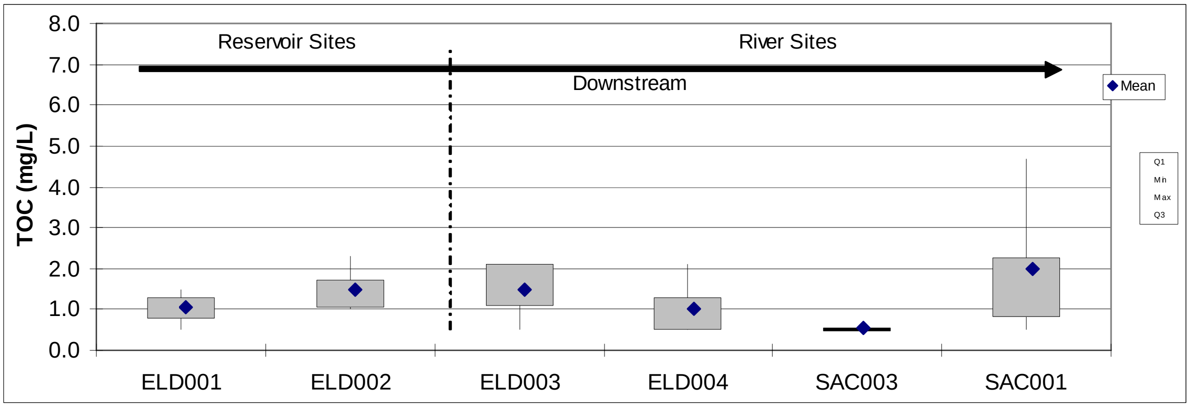


Figure 44 Summary Total Organic Carbon: Mokelumne Watershed, January - December 2002

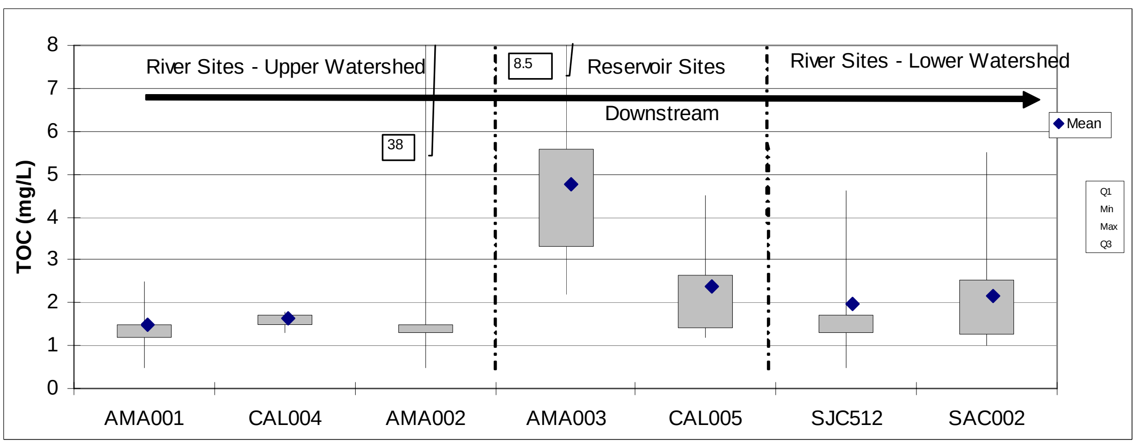


Figure 45 Summary Total Organic Carbon: Calaveras Watershed, January - December 2002

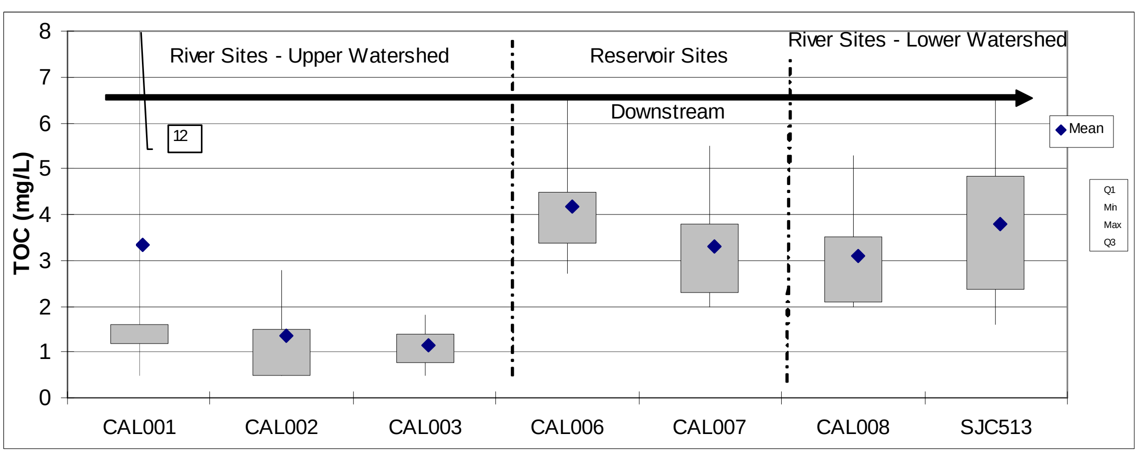


Figure 46 Biweekly Total Organic Carbon: Cosumnes Watershed, January - December 2002

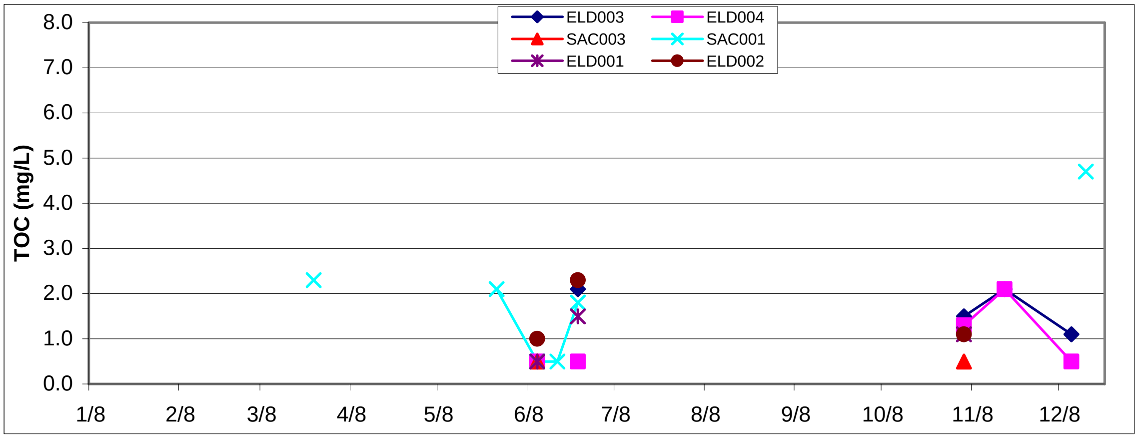


Figure 47 Biweekly Total Organic Carbon: Mokelumne Watershed, January - December 2002

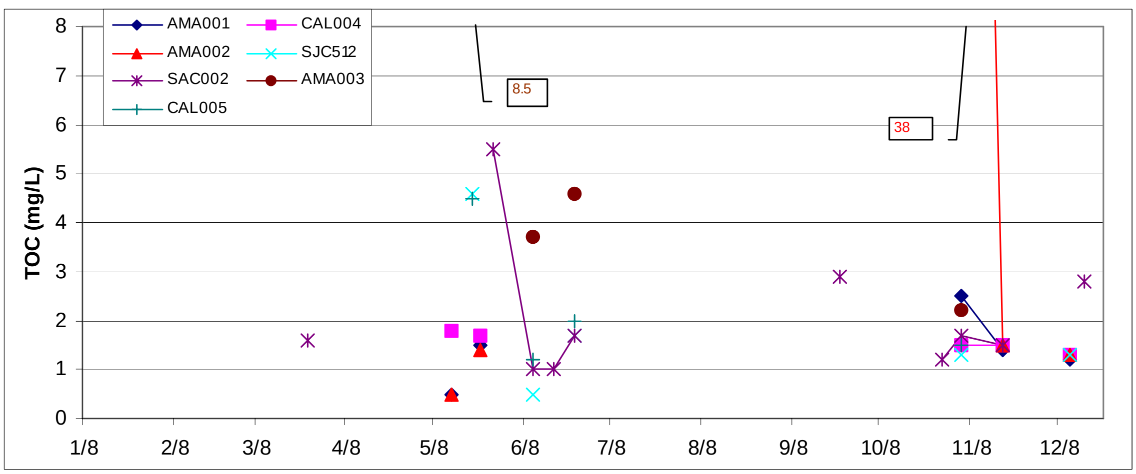


Figure 48 Biweekly Total Organic Carbon: Calaveras Watershed, January - December 2002

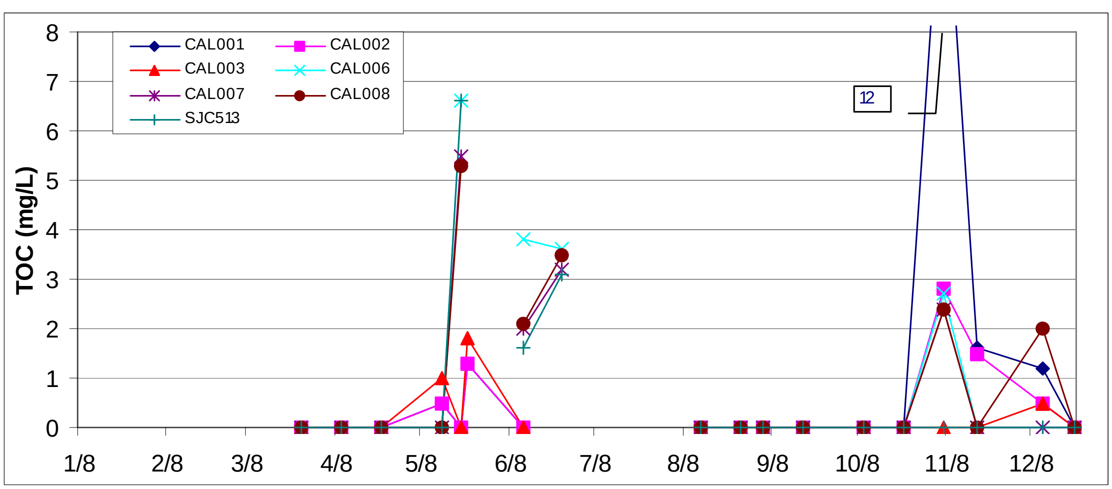


Figure 49 Summary *E. coli*: Cosumnes Watershed, January - December 2002

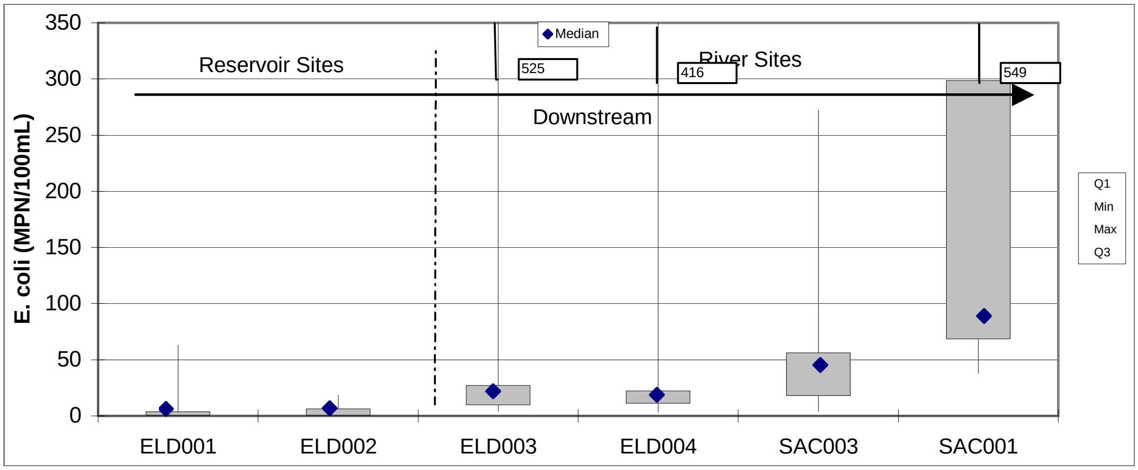


Figure 50 Summary *E. coli*: Mokelumne Watershed, January - December 2002

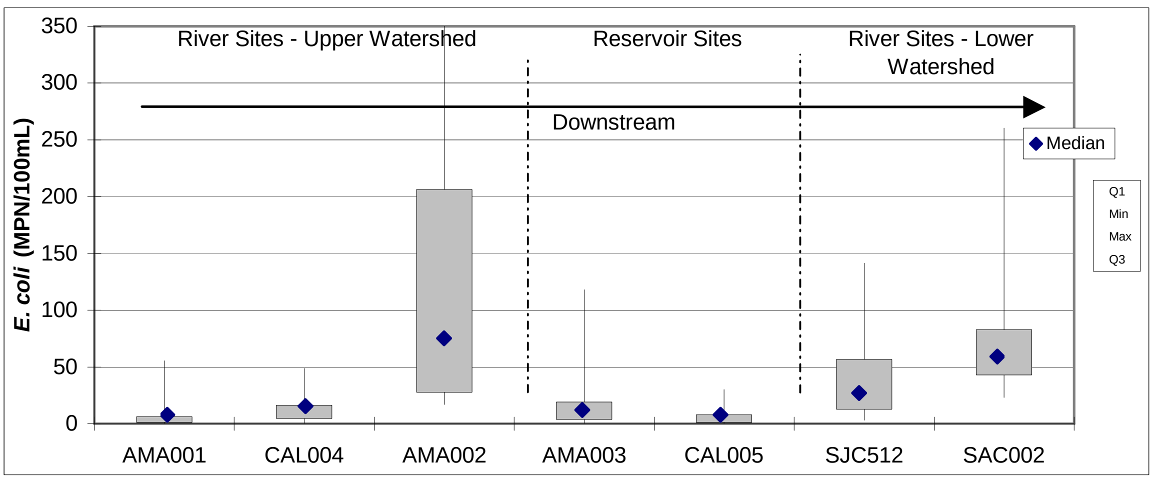


Figure 51 Summary *E. coli*: Calaveras Watershed, January - December 2002

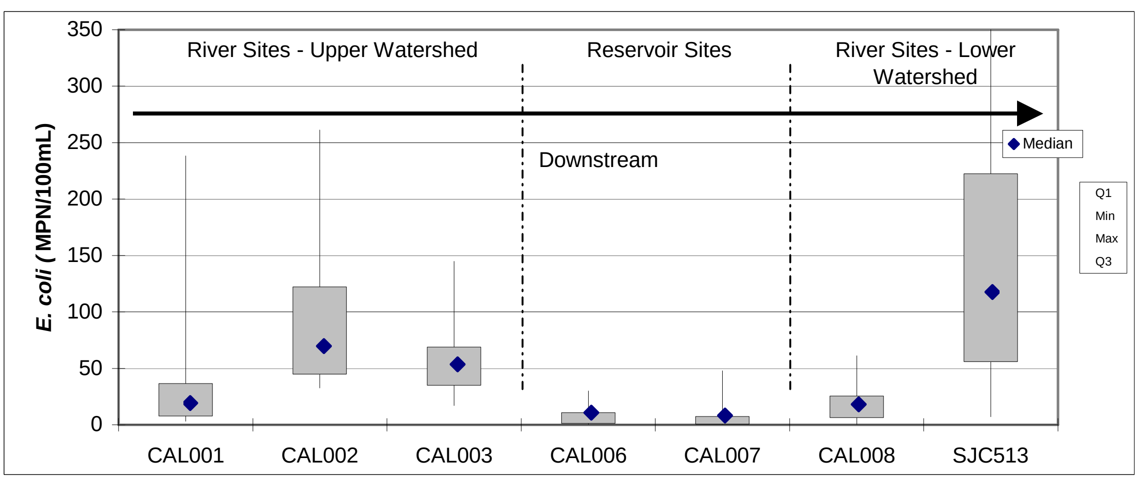


Figure 52 Biweekly *E. coli*: Cosumnes Watershed, January - December 2002

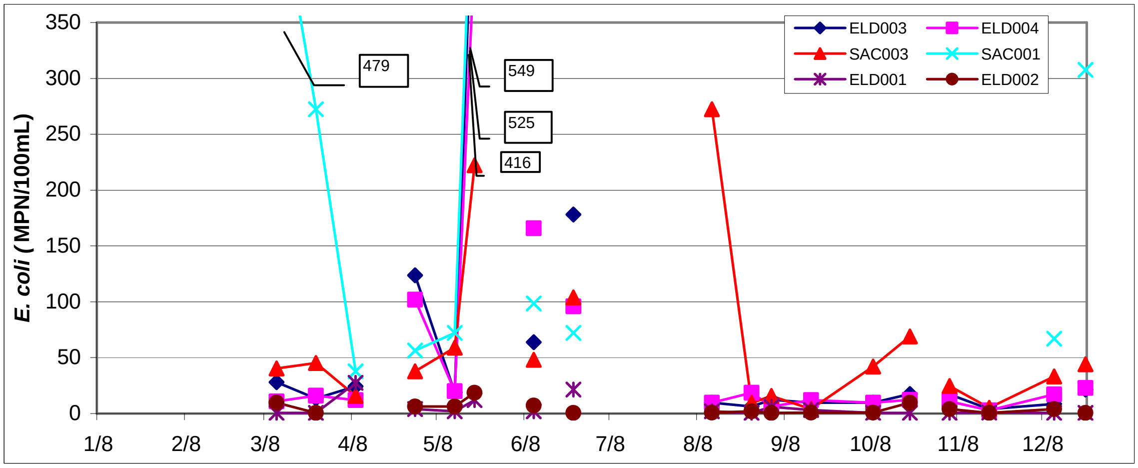


Figure 53 Biweekly *E. coli*: Mokelumne Watershed, January - December 2002

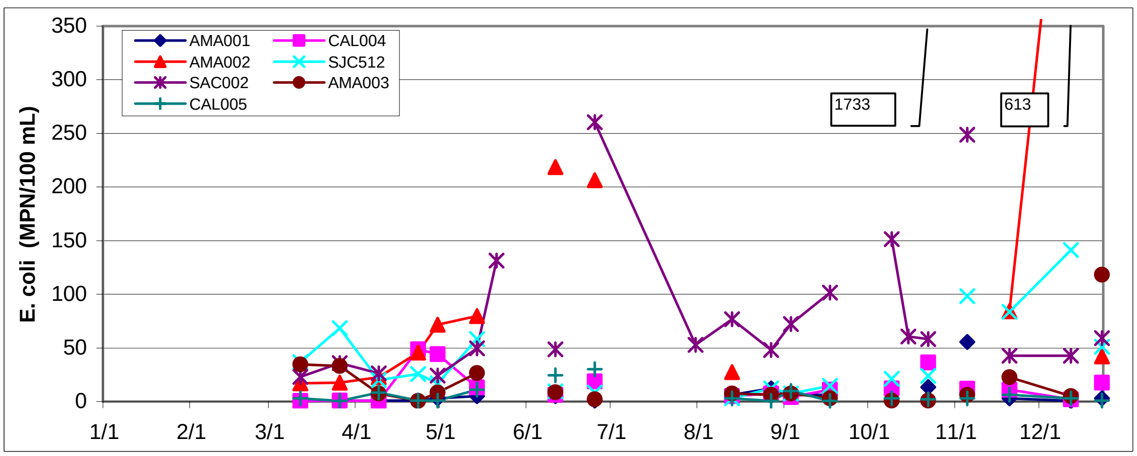
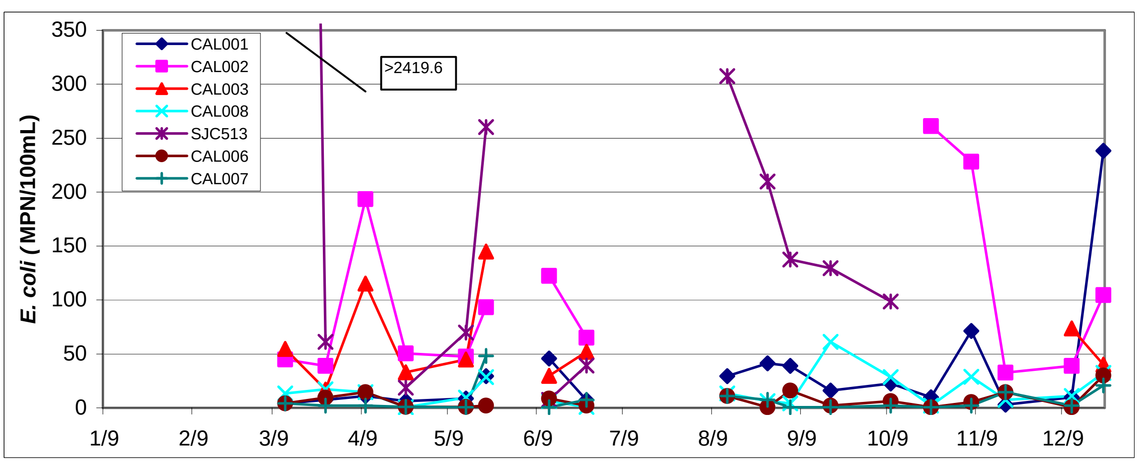


Figure 54 Biweekly *E. coli:* Calaveras Watershed, January - December 2002



7.2 Comparison of Upper Watershed, Impoundments (Lakes), Discharge from Impoundments, and Downstream Integrator Sites

Over time, hydrology in the Central Valley has become intensively managed – to the point that the Cosumnes River is the last major river without a major flow regulating reservoir. These reservoirs essentially divide the major watersheds into two distinct hydrologies – one upstream and one downstream of the impoundment.

One of the purposes of this study was to evaluate the differences between major geographic and hydrologic areas (spatial trends). Throughout the watersheds, native vegetations, with areas of rural, small foothill community influences, dominate the upper watershed areas. Rural community influences include residential, and industrial areas. The lower watershed areas transition from native barren and vacant (developable open lands, flood control channels, etc.) areas to areas dominated by agricultural uses. The land uses referenced are classifications made by Department of Water Resources (Standard Land Use Legend, 1993).

Most sites selected for this study were mainly influenced by agriculture and/or rural sources. Upper watershed sites were also selected to provide background data for each watershed upstream of the more intense land use. For the purpose of analysis, these areas can be broken into four categories:

- Upper watershed integrator: Above major regulating reservoirs and/or broad areas with little man induced alteration
- Impoundments: In this subbasin, the impoundments include Jenkinson Lake and Lake Amador, relatively small holding reservoirs, as well as Camanche and New Hogan's Reservoirs, major regulating facilities
- Discharge from impoundments (major regulating reservoirs), which essentially serves as the headwaters for the lower basins. Cosumnes River @ Michigan Bar (SAC003) has been added to this group as a comparison since it serves as a transition from higher elevation/lower impact to more intensive valley floor management, and provides a comparison of water quality when impoundments are not present.
- Downstream integrator sites: Located at the mouth of the river, representing the entire watershed

Sites within each category are listed in Table 7.

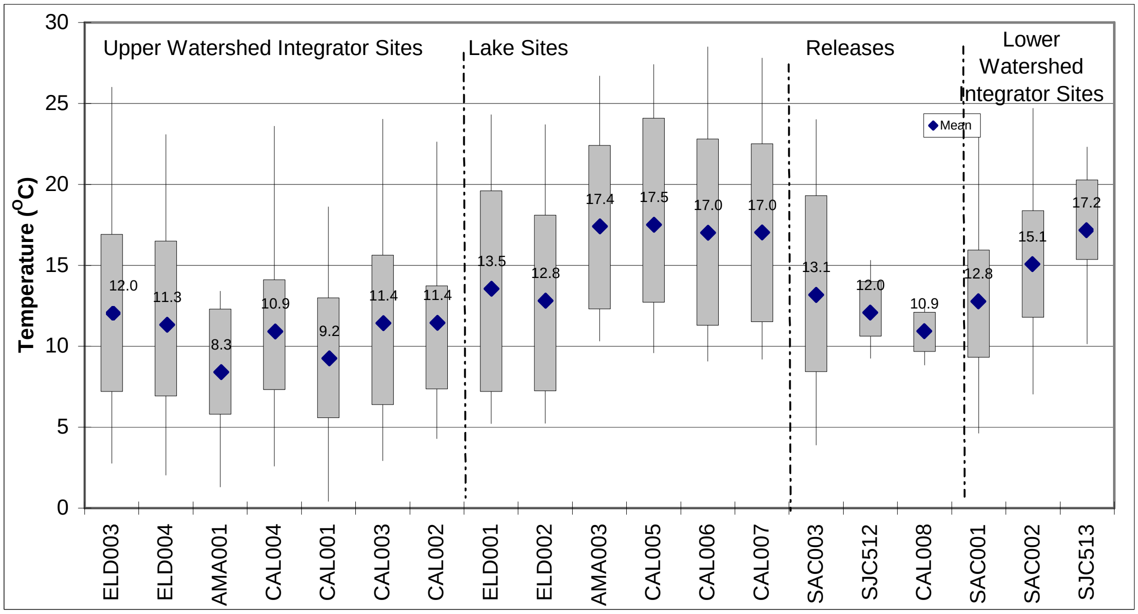
The figures in this section include both the summary ranges and means or medians of the various constituents by site and grouped into the targeted categories listed above. The summary range concentrations are identified on the right side of the figure. Mean (or median in the case of *E. coli*) values for each constituent at each site are also included.

Table 7 Comparison of Upper Watershed, Impoundments (Lakes), Discharge from Impoundments, and Downstream Integrator Sites: Northeast Basin, January - December 2002

NORTHEAST BASIN		Watershed
Upper Watershed Integrator		
ELD003	Cosumnes R. @ Gold Beach Park	Cosumnes
ELD004	Cosumnes R. @ Hwy 49	Cosumnes
AMA001	N. Fork Mokelumne R. @ Hwy 26	Mokelumne
CAL004	Mokelumne R. @ Hwy 49	Mokelumne
CAL001	San Antonio Ck. at Sheep Ranch Rd.	Calaveras
CAL002	Calaveritas Ck. at Hwy 49	Calaveras
CAL003	N. Fork Calaveras at Gold Strike Rd.	Calaveras
Reservoirs		
ELD001	Jenkinson Lake @ Pinecone	Cosumnes
ELD002	Jenkinson Lake Dam @ Mormon Emigrant.	Cosumnes
AMA003	Lake Amador @ Boat Launch	Mokelumne
CAL005	Camanche Res. @ S. Shore	Mokelumne
CAL006	New Hogan Res. at Acorn East Campground	Calaveras
CAL007	New Hogan Res. at Wrinkle Cove	Calaveras
Discharge from Impoundments		
SAC003	Cosumnes River @ Michigan Bar Rd.	Cosumnes
SJC512	Mokelumne River @ Van Assen	Mokelumne
CAL008	Calaveras River at Monte Vista	Calaveras
Downstream Integrator		
SAC001	Cosumnes River @ Twin Cities Rd.	Cosumnes
SAC002	Mokelumne River @New Hope Rd.	Mokelumne
SJC513	Calaveras River at Hwy 88	Calaveras

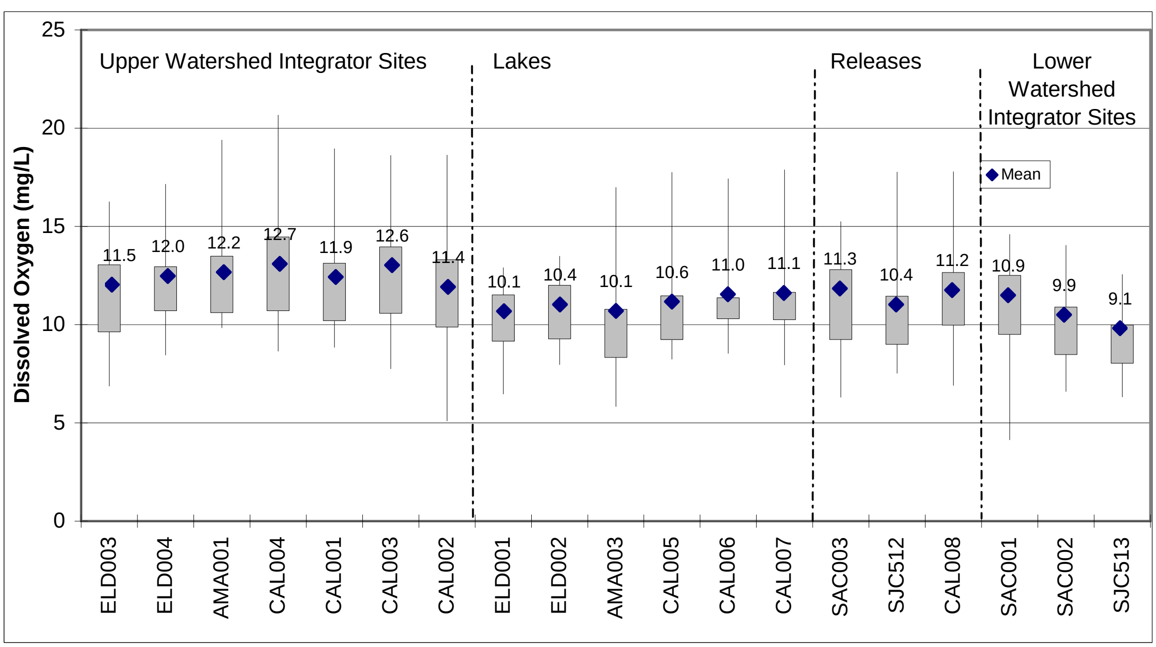
Sutter Creek (AMA002) is left out of the figures and discussion since it did not provide a comparison that relates to any of the above categories. Instead, this site is included in this basin as a study on water quality within small foothill communities, and is discussed in section 7.1.

Figure 55 Northeast Basin: Temperature



Mean temperatures at the upper watershed sites was generally cooler than the other sites, while lake sites were generally warmest. Release site mean temperatures fell between the ranges. It should be noted that lake temperatures were typically measured about 3 feet below the surface, while release sites were characteristic of temperatures near the bottom of the reservoirs. As a comparison, temperature at Cosumnes River @ Michigan Bar Road (SAC003) was more variable than the two release sites since there was no regulating feature upstream of the site. In the lower watershed integrator sites, temperature means increased moving from north to south.

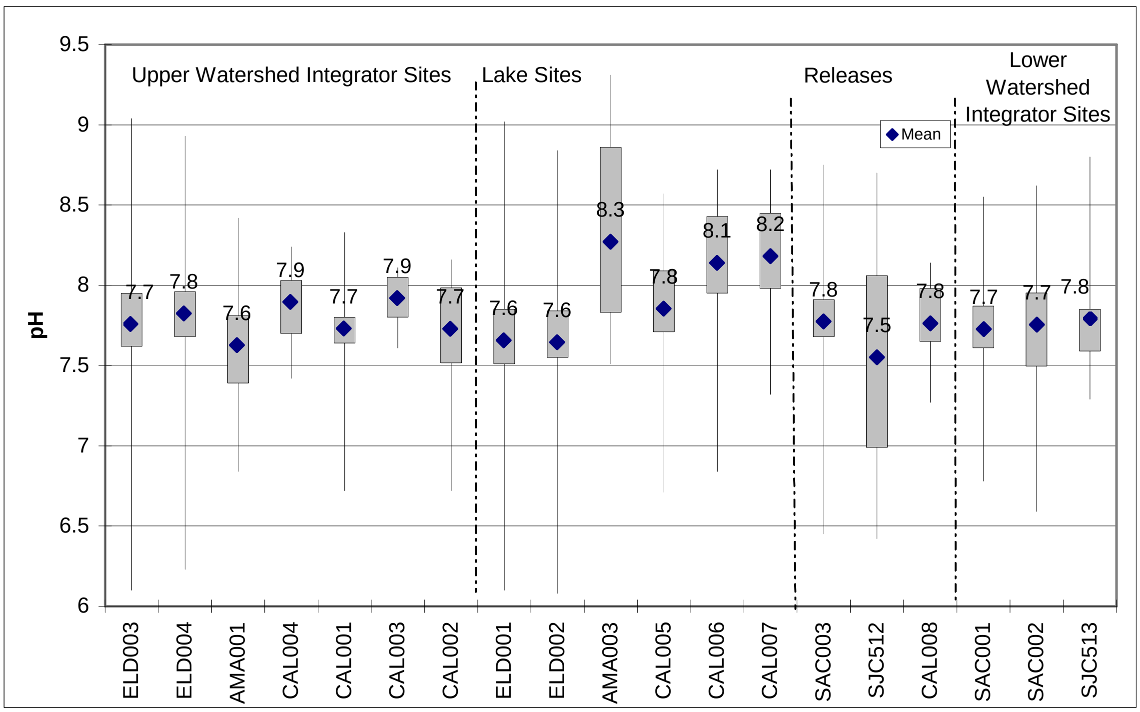
Figure 56 Northeast Basin: Dissolved Oxygen



Mean dissolved oxygen at all sites ranged from 9.1 – 12.7 mg/L, with outliers ranging from a low of 4.14 mg/L to a high of 20.6 mg/L (see Figure 56). Dissolved oxygen means were highest in the upper watershed sites, ranging from 11.4 – 12.7 mg/L. Means at the lake sites and mid watershed integrator sites ranged from 10.1 – 11.6 mg/L, and means at the lower watershed integrator sites had the lowest concentrations, ranging from 9.1 to 10.9 mg/L.

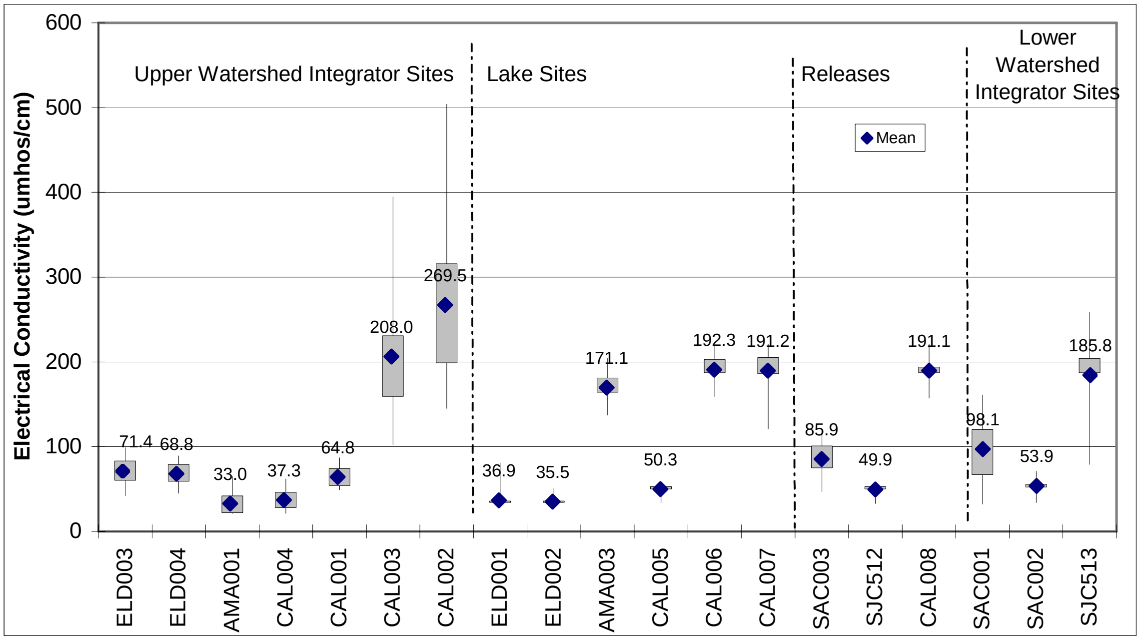
Dissolved oxygen concentrations at the lake sites ranged from a low of 5.83mg/L to a high concentration of 11.1 mg/L, with a mean of 10.5 mg/L. Means at the release sites (Mokelumne River @ Van Assen Park (SJC512) and Calaveras River @ Monte Vista Trailhead (CAL008) were similar to the reservoirs upstream of the sites (Camanche Reservoir @ South Shore (CAL005) and New Hogan Reservoir (CAL006 and CAL007), respectively, with variation within 0.2 mg/L. As a point of comparison, mean DO at Cosumnes River @ Michigan Bar Road (SAC003) was lower by 0.7 mg/L than the nearest sites upstream of the site.

Figure 57 Northeast Basin: pH



Average pH at the major regulating reservoirs was higher (more alkaline) than all other sites, ranging from 8.1 to 8.3 (Figure 57). These sites were also more basic than their respective releases indicating the variability between surface and bottom lake water quality. Lake Amador (AMA003) was the most basic of the lakes, and mainly received inflows from the rural area of Jackson. New Hogan Reservoir sites (CAL006) & (CAL007) also received drainage from rural areas, specifically the town of Jackson. Although New Hogan pH was slightly less basic than Lake Amador (AMA003), it was higher than the watershed averages.

Figure 58 Northeast Basin: Electrical Conductivity



Electrical conductivity did not appear to follow general patterns related to the overall geographic/hydrologic category. Rather, the patterns appeared to be more watershed specific with concentrations tending to increase proportionally moving from the upper watershed to the valley floor.

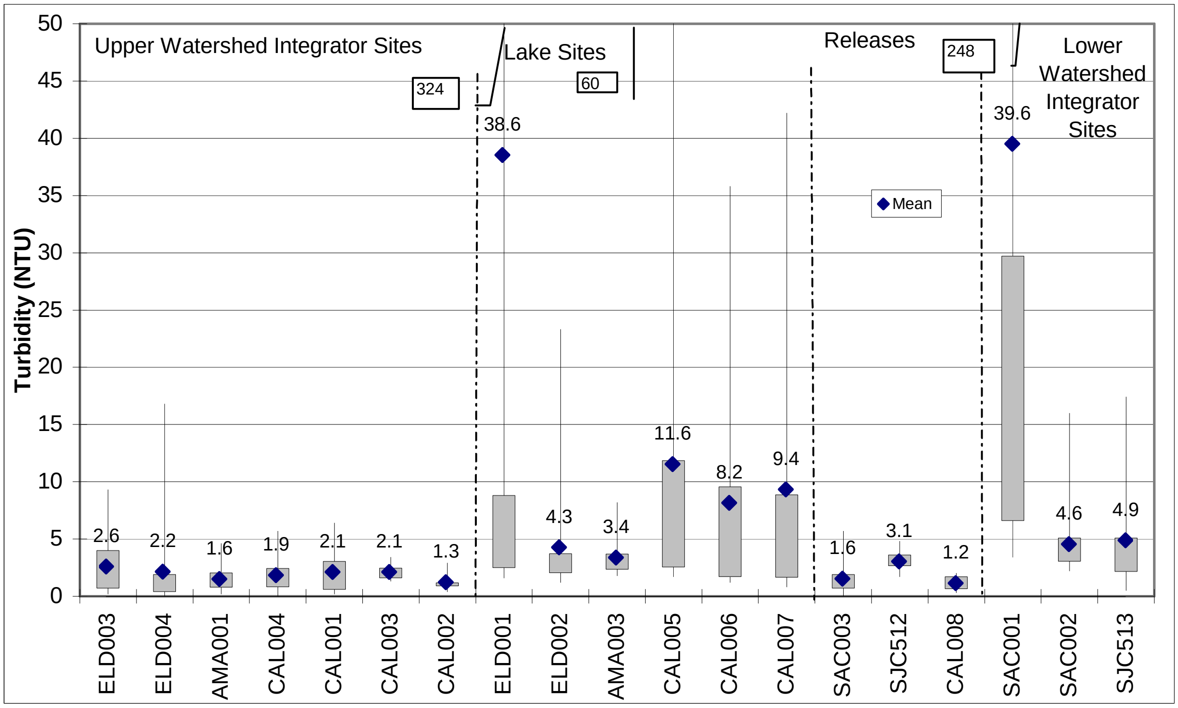
The highest mean and maximum electrical conductivity were recorded in the upper watershed of the Calaveras River at Calaveritas Creek @ Highway 49 (CAL002) and North Fork Calaveras @ Gold Strike Road (CAL003), Figure 58. Both sites are ephemeral, with dry periods beginning in August and lasting until the storm season. The highest concentrations were recorded at the first sampling after flow returned to the sites. Grazing and small foothill communities are located upstream of both sites. San Antonio Creek @ Sheep Ranch Road (CAL001) was also in the upper watershed of the Calaveras Watershed, however, this site was not ephemeral. Mean EC at CAL001 was at least 3 times lower than CAL002 and CAL003.

Reservoirs did not appear to have a significant affect on electrical conductivity. Sites above the lakes had concentrations that were similar to the lakes, but with a greater range of concentrations – Mokelumne River @ Highway 49 (CAL004) compared to Camanche Reservoir @ South Shore (CAL005) and N. Fork Calaveras @ Gold Strike Road (CAL003)/Calaveritas Creek @ Highway 49 (CAL002) compared to New Hogan Reservoir @ Acorn East Campground (CAL006)/New Hogan Reservoir @ Wrinkle Cove (CAL007). Sites immediately below the dams – Mokelumne River @ Van Assen Park (SJC512) and Calaveras River @ Monte Vista Trailhead (CAL008), respectively - had ranges of EC concentration that mirrored the lakes from which they originated.

Lake Amador (AMA003) and New Hogan Reservoir @ Acorn East Campground (CAL006)/New Hogan Reservoir @ Wrinkle Cove (CAL007) summary results were much higher than those in the Cosumnes Watershed or Camanche Reservoir @ South Shore (CAL005). The majority of inflows to Lake Amador and New Hogan Reservoir @ Acorn East Campground/New Hogan Reservoir @ Wrinkle Cove flow through the major foothill towns of Jackson and San Andreas. The ephemeral nature of the inflows to these lakes may have also influenced the EC concentrations at these sites.

Sites downstream of the releases had means that were similar to the reservoirs and were less variable than the reservoirs, as indicated by the smaller range between the 1st and 3rd Quartiles. This suggests the reservoirs have a stabilizing effect on the release water. This is supported in that 1st and 3rd Quartiles calculated for data from Cosumnes River @ Michigan Bar Road (SAC003), had a larger range than the monitoring site upstream of it.

Figure 59 Northeast Basin: Turbidity

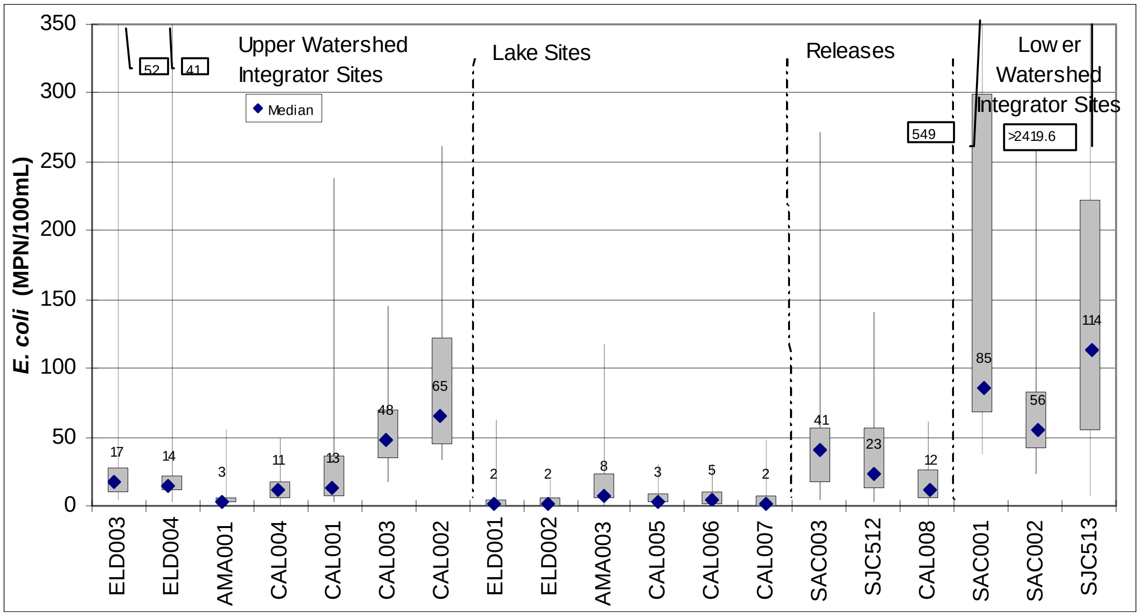


Average turbidity concentrations were under 5 NTU at most sites. (See Figure 59). Concentration ranges are scaled down to show as much detail as possible for the bulk of the data. Maximum concentrations are indicated in the text boxes.

Sites where concentrations were above 5 NTU generally were lake sites (Jenkinson Lake @ Pinecone Campsites 1-30 (ELD001), Camanche Reservoir @ South Shore (CAL005), New Hogan Reservoir @ Acorn East Campground (CAL006), and New Hogan Reservoir @ Wrinkle Cove (CAL007)). The lake sites with elevated turbidity were collected at unlined lake banks. Some of the elevated concentrations may have been result of sediment being resuspended as samples were collected or wave action near shore.

Cosumnes River @ Twin Cities Road (SAC001) also had an average above 5 NTU, at 39.6 NTU due to a single sampling event that resulted in a concentration of 248 NTU. This sampling point was the first turbidity sample collected at the beginning of the storm season, when flow returned to the dry riverbed.

Figure 60 Northeast Basin: *E. coli*



Data collected at lower watershed integrator sites resulted in the highest E. coli medians within each watershed (Figure 60). Concentration ranges are scaled down to show as much detail as possible for the bulk of the data. Maximum concentrations can be found in Table 8-1.

The E. coli concentrations at lake sites - Jenkinson Lake @ Pinecone Campsites (ELD001), Jenkinson Lake @ Mormon Emigrant Dam (ELD002), Lake Amador (AMA003), Camanche Reservoir @ South Shore (CAL005), New Hogan Reservoir @ Acorn East Campground (CAL006), and New Hogan Reservoir @ Wrinkle Cove (CAL007) - were generally lower than any other category. Minimum concentration was less than one, and the maximum concentration from this group of sites was 118 MPN/100mL. Median concentrations ranged from 2 MPN/100 mL to 7 MPN / 100mL.

Sites below dams – Mokelumne River @ Van Assen Park (SJC512) and Calaveras River @ Monte Vista Trailhead (CAL008) - had E. coli concentrations slightly higher than the lake sites, ranging from less than one MPN/100 mL to 525 MPN/100 mL. Median concentrations ranged from 12.3 to 23 MPN/100 mL. The bulk of results from Cosumnes River @ Michigan Bar Road (SAC003) was similar to Mokelumne River @ Van Assen Park (SJC512). However, the maximum concentration at Cosumnes River @ Michigan Bar Road (SAC003) was almost twice as high as the maximum concentration at Mokelumne River @ Van Assen Park (SJC512).

E. coli concentrations at the sites representing the culmination of land uses within the watersheds (the lower integrator sites at the mouths of the major rivers) ranged from 23 MPN/100 mL to >2419.6 MPN/100 mL. Median concentrations ranged from 56-114 MPN/100 mL.

Other constituents (total suspended solids, total organic carbon, toxicity, nutrients, and trace elements) were not monitored for a full twelve-month period and are not included in this discussion since they would provide only a limited trend analysis.

In summary, spatial variability appeared to be clearly delineated between the upper (elevation 600 to 3470-ft) and lower watershed. The upper watershed sites primarily received drainage from areas dominated by native vegetation, typically forested areas mixed with chaparral and rolling grassland. Some areas could receive runoff from rural foothill communities. The lower watershed areas (from 18 feet elevation to 580 feet elevation) transition from native barren and vacant areas (open lands, flood control, etc.) to areas dominated by agricultural uses. Some major cities, such as Lodi and Stockton can provide runoff to lower watershed areas.

7.3. Assessment of Beneficial Uses

One component of Region 5's SWAMP efforts is to evaluate ambient water quality and to determine whether beneficial uses are being impacted. Information gathered during the Rotational Basin portion of the strategy allowed analysis of a broad spectrum of water bodies at key integrator sites in order to determine existing quality at the site itself and allow inference of the quality of the upstream reach of the water body, as well as some initial determination of potential sources of any observed water quality concerns. Potential beneficial uses applicable to each site monitored were identified using designated listing from the Sacramento/San Joaquin Water Quality Control Plan (Basin Plan) (CVRWQCB, 2002)--discussed in more detail below. To evaluate potential impact, indicators were chosen for five broad beneficial uses: drinking water (salt, TOC, trace elements, nutrients, bacteria); aquatic life (pH, temperature, dissolved oxygen, turbidity, and water column toxicity); irrigation water supply (salt); recreation (bacteria); and waterfowl (selenium). Not all of the indicators could be monitored at each site, due to funding limitations, but at least one indicator for each beneficial use evaluated was included at each site for the study. Selenium is not discussed in detail in the following section due to all results being below the criteria for waterfowl protection (2 ug/L) (Basin Plan, 2002).

The choice of indicators came from an evaluation of USEPA EPIC indicators (USEPA, 2003), water quality objectives and goals (discussed below), and the fact that many of the indicators monitored as part of the SJR SWAMP efforts support high priority region-wide program assessments as listed in the 2005 Triennial Review of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins. Regional programs utilizing SJR SWAMP monitoring data include: Drinking Water Policy; Water Quality Objectives for Bacteria Indicators; Salinity and Boron TMDL; Central Valley Salinity Policy Development; Erosion/Sediment guidelines; and SJR Dissolved Oxygen TMDL.

The following discussion highlights specific water quality objectives and goals that were used for evaluating the indicator results and the overall assessment of beneficial use status in the Northeast Basin.

WATER QUALITY OBJECTIVES AND GOALS AND RELATED BENEFICIAL USES

Water quality information collected during this study was evaluated using both water quality objectives adopted in the Sacramento River and San Joaquin River Basin Plan (Basin Plan, 2002) and a compilation of water quality goals identified by state and federal agencies (Marshack, 2003). The Basin Plan objectives are enforceable criteria that are linked to protecting designated beneficial uses such as domestic, municipal, agricultural and industrial supply, recreation, and preservation and enhancement of fish, wildlife and other aquatic resources. These objectives are both numeric and narrative and may be specific to certain reaches of various water bodies or apply to entire basins.

The water quality goals are scientifically defensible, numeric criteria developed by diverse agencies to protect specific uses, primarily aquatic life, drinking water, and irrigation supply. In many cases, the goals are national guidelines. These goals may be used to determine compliance with some of the narrative Basin Plan objectives (e.g. toxicity).

Table 8 lists the applicable Basin Plan water quality objectives (WQOs) for this study. For turbidity, pH, temperature, and total suspended sediment, the listed objectives refer to changes impacting "normal" and "natural" conditions. For this study, natural conditions have been assumed to be conditions at the furthest upstream sampling location, below the major reservoirs, or upstream of a specific discharge. Table 8 also includes targets identified by the Bay-Delta Authority (a joint State and Federal agency) to protect fish passage (temperature), drinking water (TOC), and aquatic life/human consumption (mercury). Table 9 shows the applicable goals sorted by generalized beneficial uses.

Both the objectives and the goals are related to types of beneficial uses. In the Northeast Basin, all natural water bodies have potential municipal and industrial supply designated through the statewide Sources of Drinking Water Policy (State Water Resources Control Board Resolution No. 88-63). Other specific beneficial uses have been designated to the Consumnes, Mokelumne, and Calavaras Rivers as well as the San Joaquin River/Sacramento-San Joaquin Delta—to which the entire Northeast Basin drains. The beneficial uses of any specifically identified water body generally apply to its tributary streams. The applicable beneficial uses for each sampling site have been summarized in Table 10, under the general headings of Drinking Water, Aquatic Life, Irrigation Supply, and Recreational Use. Appendix C provides more detail on the specific subcategories of use that have been designated in the Sacramento-San Joaquin Basin Plan. Table 10 indicates whether the use has been specifically designated or is being applied as a tributary.

Table 8 Water Quality Objectives and Targets used to Analyze Data

Constituent	Location/Comment		Dates	Objective		
SACRAMENTO-SAN JOAQUIN BASIN PLAN OBJECTIVES (Basin Plan, 2002)						
Numeric						
Arsenic (Dissolved)	Sacramento-San Joaquin Delta		all	0.01 mg/L		
Copper (Dissolved)[1]	Sacramento-San Joaquin Delta		all	0.01 mg/L[1]		
Dissolved Oxygen	Outside Delta (legal boundaries)[3]	Cold/Spawning: Cosumnes, Mokelumne, Calaveras, Spawning[2]: Mendota dam to Vernalis.	all	7.0 mg/L		
Electrical Conductivity	San Joaquin River at Airport Way Bridge, Vernalis; Old River at Tracy Road Bridge[8]		Apr 1- Aug 31	700 µmhos/cm		
			Sep 1- Mar 31	1000 µmhos/cm		
pH[4]	In fresh waters with designated COLD or WARM beneficial uses.		all	6.5 - 8.5		
Selenium (Total)	San Joaquin River, mouth of the Merced River to Vernalis		all	12 µg/L		
				4 day Average	5 µg/L	
	Salt Slough, Mud Slough (north), and the San Joaquin River from Sack Dam to the mouth of Merced River		all	20 µg/L		
				4 day Average	5 µg/L	
	Salt Slough and constructed and re-constructed water supply channels in the Grassland watershed listed in Appendix 40 (See Basin Plan).		all	20 µg/L		
				Monthly mean	2 µg/L	
Temperature[4]	Deer Creek, source to Cosumnes River. The following applies to daily maximum temperature. For Monthly average temperature see Resolution R5-2005-0119 (ephemeral water body).		See Resolution R5-2005-0119	Range 63-81ºF		
Turbidity	Delta waters[5]: except for periods of storm runoff	Central Delta	all	50 NTU		
		other Delta waters	all	150 NTU		
	Sacramento River and San Joaquin River Basins[5]		all	Where natural turbidity is between:	0-5 NTU	no >1 NTU
					5-50 NTU	no >20%
					50-100 NTU	no >10 NTU
					>100 NTU	no >10%
	Deer Creek, source to Cosumnes River. The following applies to daily maximum turbidity. For daily average turbidity see Resolution R5-2002-0127. (ephemeral water body)		all	Where the dilution ratio for discharges is < 20:1 and natural turbidity is:	<1 NTU	no >5 NTU
				Where natural turbidity is:	1-5 NTU	no >5 NTU

			Where the dilution ratio for discharges is $\geq$20:1 and natural turbidity is:	>5 NTU	General turbidity objectives
Zinc (Dissolved) [1]	Sacramento-San Joaquin Delta	all	0.1 mg/L[1]		
Narrative					
pH[4]	Sacramento River and San Joaquin River Basins	all	Changes in normal ambient pH levels shall not exceed 0.5 in fresh waters with designated COLD or WARM beneficial uses.		
Temperature[4]	Sacramento River and San Joaquin River Basins	all	At no time or place shall the temperature of intrastate waters be increased more than 5 ºF above natural receiving water temperature.		
Toxicity	Sacramento River and San Joaquin River Basins	all	All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.		
TSS	Sacramento River and San Joaquin River Basins	all	The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.		
SACRAMENTO-SAN JOAQUIN BASIN PLAN OBJECTIVES (Title 22 of the California code of regulations, which are incorporated by reference into the Sacramento-San Joaquin Basin Plan Objectives*)					
Arsenic (Total)	Water Bodies Designated as Municipal and Domestic Supply (MUN)-Drinking Water. California Primary MCL	all	50 µg/L		
Cadmium (Total)		all	5 µg/L		
Chloride		all	Maximum Contaminant Level Ranges	Recommended	250 mg/L
				Upper	500 mg/L
				Short Term	600 mg/L
Chromium (Total)		all	50 µg/L		
Copper (Total)		all	1000 µg/L		
Lead (Total)		all	15 µg/L		
Mercury (Total)		all	2 µg/L		
Nickel (Total)		all	100 µg/L		
Nitrate (as NO_3)		all	45 mg/L		
Nitrate-N		all	10 mg/L		
Electrical Conductivity		all	Maximum Contaminant Level Ranges	Recommended	900 µmhos/cm
				Upper	1600 µmhos/cm
				Short Term	2200 µmhos/cm
Selenium		all	50 µg/L		
Sulfate		all	Maximum Contaminant Level Ranges	Recommended	250 mg/L
				Upper	500 mg/L
				Short Term	600 mg/L
TDS		all	Maximum Contaminant Level Ranges	Recommended	500mg/L
				Upper	1000mg/L
				Short Term	1500 mg/L
Turbidity		all	5 NTU		
Zinc (Total)		all	5000 µg/L		

BAY-DELTA AUTHORITY TARGETS (CALFED Water Quality Program Plan, 2000)			
Mercury	East of Antioch Bridge	All	2.1 µg/L
Temperature[6/7]	San Joaquin River at Vernalis	April 1 - Jun 30 and Sept 1- Nov 30	<68 ºF
TOC	Source water quality for the Delta	all	3.0 mg/L

*Title 22 of the California code of regulations, which are incorporated by reference into the Sacramento-San Joaquin Basin Plan Objectives: Table 64431-A (Inorganic Chemicals), Table 64449-A (Secondary Maximum contaminant Levels-consumer Acceptance Limits) and Table 64449-B (Secondary Maximum Contaminant Levels-Ranges). Lead is stated in Article 19, Section 64468.1 and also in the Basin plan (III-3). Use the following objectives unless otherwise stated above.

[1] The effects of these concentrations were measured by exposing test organisms to dissolved aqueous solutions of 40 mg/L hardness that had been filtered through a 0.45 micron membrane filter. Where deviations from 40 mg/L of water hardness occur, the objectives, in mg/L, shall be determined using the following formulas: (As hardness increases Cu and Zn increase)

$$Cu = e^{(0.905)(\ln \text{hardness})-1.612} \times 10^{-3}$$

[2] Spawning was used in areas designated as WARM <u>and</u> SPAWNING (Applied most limiting)

[3] Apply most limiting.

[4] Contains narrative and Numeric. Apply most limiting.

[5] Exceptions to the following limit will be considered when a dredging operation can cause an increase in turbidity.

[6] Daily average temperature in all water-year types.

[7] Central Valley Regional Water Quality Control Board (CVRWQCB) Water Quality Control Plan

[8] Maximum 30-day running average of mean daily, in µmhos/cm

Table 9 Water Quality Goals Used to Analyze San Joaquin River SWAMP Data: Indicators and Beneficial Uses (Basin Plan, 2002)

Indicator(s)	Units	SJR-BENEFICIAL USE(S)			
		Drinking Water	Aquatic Life	Irrig. Water Supply	Rec. Use
Ammonia Nitrogen (NH_3-N)	mg N/L		24.1[u1]		
			36.1[u2]		
Arsenic (dissolved)	µg/L		340[f]		
Arsenic (total)	µg/L	0.004[m]		100[e]	
		10[t]			
Cadmium (dissolved)	µg/L		1.6[r]		
Cadmium (total)	µg/L	0.07[m]	1.6[r]	10 [e]	
Copper (dissolved)	µg/L		5.7[h]		
Copper (total)	µg/L	1300[g]	5.9[h]	200[e]	
		170[m]			
E. coli	MPN/100mL				235 [v]
					298 [w]
					409 [x]
					575 [y]
Electrical Conductivity	µmhos/cm			700[e]	
Lead (dissolved)	µg/L		23.5[l]		
Lead (total)	µg/L	2[m]	25.4[l]	5000[e]	
Mercury (total)	µg/L	0.05[g]	1.4 [j]		
		1.2[m]			
Nickel (dissolved)	µg/L		215.7[n]		
Nickel (total)	µg/L	610[g]	216.1[n]	200[e]	
		12[m]			
Nitrate-nitrogen (NO_3-N)	mg/L	10[m]			
Selenium	µg/L	35[q]	20[b]	20[e]	
Total Dissolved Solids	mg/L			450[e]	
Zinc (total)	µg/L	2100[q]	55.1[o]	2000[e]	
Zinc (dissolved)	µg/L		53.9[o]		

[a] California DHS Action Level for drinking water
[b] National Toxics Rule (USEPA) / 1-hour average (total)
[c] Taste and odor threshold (USEPA Drinking Water Advisory)
[d] USEPA Drinking Water Advisory for persons on restricted sodium diet
[e] Water Quality for Agriculture (Ayers & Westcot)
[f] California Toxics Rule (USEPA)/ 1-hour average
[g] California Toxics Rule (USEPA) for sources of drinking water
[j] USEPA National Ambient W Q Criteria / 1-hour average
[h] California Toxics Rule (USEPA): The concluding concentration was determined by using a 40 mg/L hardness. Where deviations from 40 mg/L of water hardness occur, the goals, in mg/L, shall be determined using the following formulas: (As hardness increases copper increases)

Maximum concentration (1-hour Average, total recoverable)
=(e(0.9422*LN(hardness)-1.700))
Maximum concentration (1-hour Average, dissolved)
=(e(0.9422*LN(hardness)-1.700))*(0.960)

[l] California Toxics Rule (USEPA): The concluding concentration was determined by using a 40 mg/L hardness. Where deviations from 40 mg/L of water hardness occur, the goals, in mg/L, shall be determined using the following formulas: (As hardness increases lead increases)

Maximum concentration (1-hour Average, dissolved)

=(e(1.273*LN(hardness)-1.460))*(1.46203-(LN(hardness)*0.145712))
Maximum concentration (1-hour Average, total recoverable)
=(e(1.273*LN(hardness)-1.460))

[m] California Public Health Goal for Drinking Water

[n] California Toxics Rule (USEPA): The concluding concentration was determined by using a 40 mg/L hardness. Where deviations from 40 mg/L of water hardness occur, the goals, in mg/L, shall be determined using the following formulas: (As hardness increases nickel increases)

Maximum concentration(1-hour Average, dissolved)=e(0.8460*LN(hardness)+2.255))*(0.998)
Maximum concentration(1-hour Average, total recoverable)=e(0.8460*LN(hardness)+2.255)

[o] California Toxics Rule (USEPA): The concluding concentration was determined by using a 40 mg/L hardness. Where deviations from 40 mg/L of water hardness occur, the goals, in mg/L, shall be determined using the following formulas: (As hardness increases zinc increases)

Maximum concentration (1-hour Average, total recoverable)=(e(0.8473*LN(hardness)+0.884))
Maximum concentration(1-hour Average, dissolved)=(e(0.8473*LN(A13)+0.884))*(0.978)

[q] USEPA IRIS Reference Dose (Assumes 70 kg body weight, 2 liters per day drinking water consumption, and 20 percent relative source contribution. An additional uncertainty factor of 10 is used for Class C carcinogens.)

[r] California Toxics Rule (USEPA): The concluding concentration was determined by using a 40 mg/L hardness. Where deviations from 40 mg/L of water hardness occur, the goals, in mg/L, shall be determined using the following formulas: (As hardness increases cadmium increases)

Maximum concentration (1-hour Average, dissolved)
=(exp(1.128*LN(hardness)-3.6867))*(1.136672-(LN(hardness)*0.041838))
Maximum concentration (1 hour Average, total recoverable)
=(exp(1.128*LN(hardness)-3.6867))

[t] USEPA Primary MCL

[u1&2] USEPA National Ambient Water Quality Criteria: the concluding concentration was determined by using a pH of 7. Where deviations from pH of 7 occur, the goal, in mg/L, shall be determined using the following formulas: (As pH becomes more acidic total ammonia Nitrogen increases)

Criteria Maximum concentration 1-hour Average (mg N/L):

Salmonids 1- Present: $$CMC=\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}$$

2- Absent: $$CMC=\frac{0.411}{1+10^{7.204-pH}}+\frac{58.4}{1+10^{pH-7.204}}$$

[v] USEPA Guideline - Single Sample Maximum Allowable Density: designated Beach Area (upper 75% C.L.)

[w] USEPA Guideline - Single Sample Maximum Allowable Density: moderate full body contact recreation (upper 82% C.L.)

[x] USEPA Guideline - Single Sample Maximum Allowable Density: lightly used full body contact recreation (upper 90% C.L.)

[y] USEPA Guideline - Single Sample Maximum Allowable Density: infrequently used full body contact recreation (upper 95% C.L.)

Table 10 Applicable Beneficial Uses for Water Bodies in the Northeast Basin

		APPLICABLE BENEFICIAL USES											
		DRINKING WATER	AQUATIC LIFE						IRRIGATION SUPPLY	RECREATION			Designated (D) or Tributary (T)
		Municipal and Domestic Supply	Freshwater		Migration		Spawning			REC-1		REC-2	
Site Description	Site ID		Warm	Cold	Warm	Cold	WarM	Cold		Contact	and Rafting	Other Noncontact	
Cosumnes Watershed River Sites													
Cosumnes R. @ Gold Beach Park	ELD003	E	E	E	E	E	E	E	E	E	E	E	**D**
Cosumnes R. @ Hwy 49	ELD004	E	E	E	E	E	E	E	E	E	E	E	**D**
Cosumnes R. @ Michigan Bar Road	SAC003	E	E	E	E	E	E	E	E	E	E	E	**D**
Cosumnes River @ Twin Cities Road	SAC001	E	E	E	E	E	E	E	E	E	E	E	**D**
Cosumnes Watershed Lake Sites													
Jenkinson Lake @ Pincone Campground	ELD001	E	E	E	E	E	E	E	E	E	E	E	**T**
Jenkinson Lake Dam @ Mormon Emigrant	ELD002	E	E	E	E	E	E	E	E	E	E	E	**T**
Mokelumne Watershed River Sites													
N. Fork Mokelumne R. @ Hwy 26*	AMA001	E	E	E	E		E	E		E	E	E	**D**
Sutter Creek @ Hwy 49	AMA002	E	E	E	E	E	E	E	E	E	E	E	**T**
Mokelumne R. @ Hwy 49*	CAL004	E	E	E	E		E	E		E	E	E	**D**
Mokelumne R. @ Van Assen	SJC512	E	E	E	E	E	E	E	E	E	E	E	**D**
Mokelumne River @New Hope Road	SAC002	E	E	E	E	E	E	E	E	E	E	E	**D**
Mokelumne Watershed Lake Sites													
Lake Amador @ Boat Launch	AMA003	E	E	E				E		E		E	**D**
Camanche Reservoir @ South Shore	CAL005	E	E	E	E		E	E	E	E		E	**D**
Calaveras Watershed River Sites													
San Antonio Creek @ Sheep Ranch Road*	CAL001	E	E	E	E		E	E		E	E	E	**T**
Calaveritas Creek @ Hwy 49*	CAL002	E	E	E	E		E	E		E	E	E	**T**
N. Fork Calaveras R. @ Gold Strike Road.*	CAL003	E	E	E	E		E	E		E	E	E	**D**
Calaveras R. @ Monte Vista Trailhead	CAL008	E	E	E	E	E	E	E	E	E	E	E	**D**
Calaveras R. @ Hwy 88	SJC513	E	E	E	E	E	E	E	E	E	E	E	**D**
Calaveras Watershed Lake Sites													
New Hogan Res. @ Acorn East CG	CAL006	E	E	E	E		E	E		E		E	**D**
New Hogan Reservoir @ Wrinkle Cove	CAL007	E	E	E	E		E	E		E		E	**D**

E=Existing P=Potential

BENEFICIAL USE EVALUATION

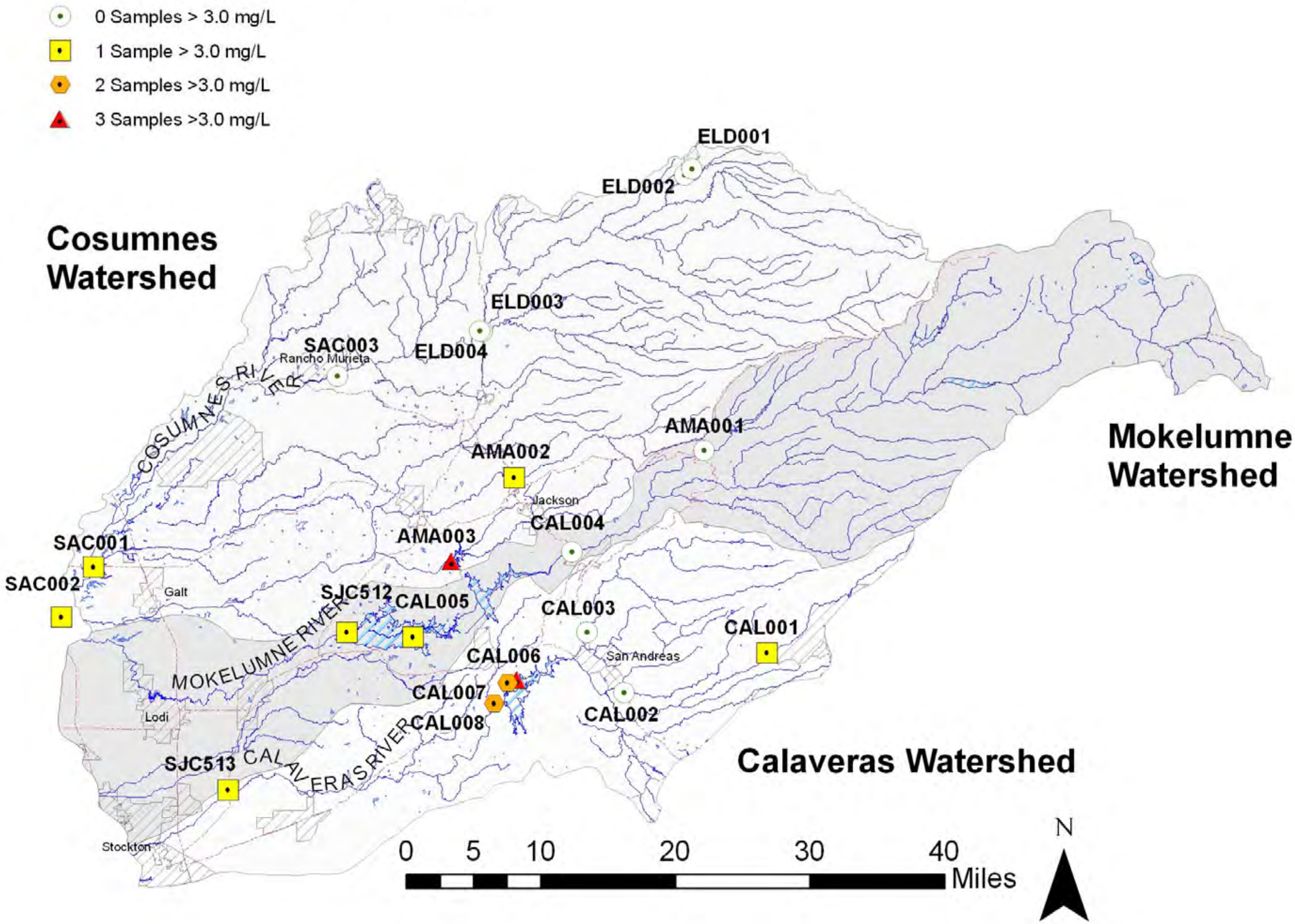
Drinking Water (salt, TOC, trace elements, bacteria, nutrients)

Indicators used to evaluate a potential impact to drinking water (sources of municipal and domestic supply) included salt measured as electrical conductivity (umhos/cm), total organic carbon (TOC), turbidity, selected trace elements (total and dissolved arsenic, cadmium, copper, mercury, nickel, lead and zinc), and bacteria (E. coli as an indicator of potential pathogens). For all of the indicators except E. coli, there are specific numeric objectives or goals that results can be evaluated against (Table 12 in section 8.0 Summary/Conclusion). The presence of E. coli indicates that the water would need to be treated prior to consumption but there are no specific numeric criteria for source water related to consumption.

The drinking water recommended maximum contaminant level for salt measured as specific conductance is 900 umhos/cm, with an upper continuous limit of 1600 umhos/cm and short term exposure of 2200 umhos/cm. Maximum EC concentrations at all of the sites monitored were below the recommended maximum limit (900 umhos/cm). Chloride and sulfate were not measured during the survey.

The TOC goal of 3.0 mg/L is based on the Bay Delta Authority's guideline for water quality in the Sacramento-San Joaquin Delta (CALFED Water Quality Program Plan, 2000). This indicator was chosen to help identify potential sources of TOC to the Delta since all water bodies monitored flow into the San Joaquin River and ultimately the Delta. Due to limited funding, TOC was only collected at most sites during May, June and November 2002. Expanded monthly sampling occurred at the downstream most sites for each of the three major rivers, when the sites were not dry. In general, the highest individual concentrations occurred at sites in the uppermost watershed in areas above the reservoirs and appeared to be linked to major storm events in May and November. In particular, during November, when the sampling coincided with the leading edge of a major storm, TOC concentrations reached 38 mg/L in Sutter Creek (AMA002) and 12 mg/L in San Antonio Creek (CAL001). Maximum concentrations in the Consumnes watershed remained below 3.0 mg/L, except for a single storm event in December 2002, where concentrations peaked at 4.7 mg/L at the lower watershed site (Twin Cities Road, SAC001). Higher maximum concentrations (ranging from 1.5-8.5 mg/L) occurred in the large regulating reservoirs in the Mokelumne and Calaveras Watersheds (Figure 62). Elevated TOC concentrations appear directly linked to storm events and were regularly reported above 3.0 mg/L in the Mokelumne and Calavaras Watersheds during May and November.

Figure 61 Number of Total Organic Carbon Samples with Concentrations Greater than Bay Delta Criteria (Sampled May, June, November)



Drinking Water (Electrical Conductivity, Total Organic Carbon, Trace Elements, *E. coli*, Nutrients)

Monitoring for specific trace elements was also limited due to funding, with 2-sampling events in June 2002. All results fell below the objectives and goals outlined in Table 12.

E. coli was monitored as a pathogen indicator. For drinking water, pathogen criteria are typically set at the tap and are recommended at zero. No specific numeric criteria exist for source water. E. coli was detected at least once at every site, with the highest concentrations typically occurring during spring runoff (April through June) and again during fall flush in October. Median concentrations for all the river sites ranged from 3 to 114-MPN, while the impoundment medians ranged from 2 – 8 MPN. Three sites with particularly elevated E. coli throughout the year were Sutter Creek (AMA002), Consumnes River at Twin Cities (SAC001), and Calaveras River at HWY 88 (SJC513). Median E. coli concentrations at these three sites ranged from 76 to 114 MPN, with maximum levels >2420 MPN at both Sutter Creek and Calaveras River at HWY 88. Based on the findings, water from the Northeast basin should be treated for pathogens prior to drinking water use, with particular diligence during spring runoff and fall flush.

In summary, none of the specific objectives or goals for municipal and domestic supply are being exceeded within the watershed, although, elevated TOC concentrations during storm runoff are indicative of potential to impact downstream Delta waterways and seasonally elevated levels of E. coli may indicate the presence of pathogens and a requirement of treatment prior to use for municipal supply

Aquatic Life (pH, temperature, dissolved oxygen, turbidity, and water column toxicity)

For those water bodies designated for COLD or WARM beneficial uses, the Basin Plan specifies both numeric and narrative pH water quality objects. The numeric WQO specifies a specific range of 6.5 to 8.5 units, while the narrative indicates that changes in normal ambient pH levels shall not exceed 0.5 units. In the Northeast Basin, pH is very closely related to the season, with annual ranges from 6.1 to 9.0 units. However, ranges in minimum and maximum pH within each watershed (e.g. 6.1 to 6.8 units in the Consumnes watershed and 8.2 to 8.7 units in the Mokelumne watershed, repectively) fall near the 0.5 unit range. Every site measured in the Consumnes watershed fell outside of the numeric WQO for pH at some point during the year. For the Mokelumne watershed, only the Mokelumne River at Van Assen (SJC512) exceeded the upper numeric limit (8.5-units) on one sampling event. Within the Calaveras River Watershed, only the most downstream site, the Calaveras River at HWY 88 exceeded the upper numeric limit. In contrast to the river sites, every impoundment exceeded the upper numeric limit of 8.5 pH units at least once, with Lake Amador remaining above 8.5 for the majority of the summer.

Temperature tracked season, especially for the Consumnes River sites and for the sites above the major regulating reservoirs, where little difference was seen between individual sites. All maximum temperatures recorded were below the WQO of 81-degree F (27.2-degree C) identified for Deer Creek, an ephemeral stream feeding the Consumnes River. Surface water in the major reservoirs reported the highest overall values, while the discharges from those reservoirs into the Mokelumne and Calavaras Rivers reported the most stable continuous temperatures, ranging from 8.8 to 15-degree C, annually. Sites in the uppermost elevations (greater than 3500-ft) of the Mokelumne watershed recorded the lowest overall temperatures, ranging from 1.3 to 13-degrees C. The remainder of the sites more closely reflected the seasonal temperatures reported for the un-dammed/regulated Consumnes River.

All sites exceeded the Calfed Guideline of 20-degree C from April 1 to June 30 and September 1 to December 31, except:

Calaveras Watershed
CAL001—San Antonio Creek @ Sheep Ranch Road
CAL002—Calaveritas Creek @ Highway 49

Mokelumne Watershed
CAL004—Mokelumne @ HWY 4
AMA001—North Fork Mokelumne @ HWY 26
SJC512—Mokelumne @ Van Assen

The dissolved oxygen (DO) WQO of 7.0 mg/L was met at all sites except as follows:
ELD003 – Cosumnes River @ Gold Beach on 8/13/02 (6.87 mg/L DO)
SAC003—Consumnes River @ Michigan Bar on 8/13/02 (6.31 mg/L DO)
SAC001—Consumnes River @ Twin Cities on 2/12/02 (4.14 mg/L DO)
AMA002—Sutter Creek on 11/7/02 (5.7 mg/L DO)
SAC002—Mokelumne @ New Hope on 9/24/02 (6.60 mg/L DO)
CAL002—Calaveritas Creek @ HWY 49 on 10/24/02 (5.10 mg/L DO) and 11/07/02 (6.46 mg/L DO)
CAL008 – Calaveras River @ Monte Vista Trailhead on 10/28/02 (6.90 mg/L DO)
SJC513—Calaveras River @ HWY 88 on 5/13/02 (6.32 mg/L DO)

For Sutter Creek and Calaveritas Creek at HWY 88, the reduced DO recordings occurred during the first flush storm event after the creek beds had been dry for several months.

On occasion, surface water measured in Sly Park Reservoir (6/25/02) and Lake Amador (8/26/02) were recorded below 7.0 mg/L DO, but no fish kills were observed.

Turbidity at all the sites except for the Consumnes @ Twin Cities, fell into a background range of 0 – 5 NTU with large spikes typically related to storm events. The Consumnes River site at Twin Cities Road ranged from 3.4 to 31.1 NTU when flowing in the spring and early summer, then dried up with the first flush storm event in December 2002 resulting in 250-NTU. Specific exceptions to this general rule included the reservoir sites where surface level bank samples could have been greatly impacted by wave action.

Toxicity samples were collected in September 2002 for C. dubia (to represent impacts from organics such as pesticides) and fathead minnows (representing impacts from nutrients). No acute toxicity was observed in any sample.

In summary, overall aquatic life use appears protected in all water bodies evaluated with some concern of elevated temperatures in the downstream most reaches of each of the major rivers during the spring and fall migration seasons. The elevated temperatures mimic the trend for the Consumnes River, therefore a more thorough temperature survey and comparison is needed prior to determining potential impairment.

<u>Irrigation Water Supply (Salt represented by EC)</u>

All water within the Northeast sub-basin flows into the Sacramento San Joaquin Delta and as such have been evaluated against the WQO applicable to the San Joaquin River at Vernalis and Old River at Tracy for protection of irrigation supply. The WQO is seasonal: 700 umhos/cm from April 1 to August 31; and 1000 umhos/cm from September 1 to March 31. Concentrations at all sites fall below 700 umhos/cm indicating that use for irrigation is met year round.

<u>Recreation (Bacteria)</u>

Bacteria is used as an indicator to determine likelihood of pathogens in the water column. The current Basin Plan WQO focuses on fecal coliform concentrations (<200-MPN for a 5-day geometric mean or <400-MPN for a single sample). Analyses for this study utilized E. coli, a subset of fecal coliform. Use of E. coli allowed both a conservative evaluation against the Basin Plan WQO as well as a comparison to USEPA guidelines for various levels of recreational contact (listed below).

Level of Contact	USEPA E. Coli Guideline (MPN/100ml)
Swimming	<234
Designated beach area	235 – 297
Moderate full body contact	298 – 408
Light full body contact	409 – 574
Infrequent full body contact	>574

E. coli exceeded the one time fecal coliform WQO (400 MPN/100ml) in seven of the 330 samples analyzed as follows:

Site	Code	Date	E. coli (MPN)
ELD003 Cosumnes @ Gold Beach	(S)	5/21/02	525
ELD004 Cosumnes @ HWY 49	(S)	5/21/02	416
SAC001 Cosumnes @ Twin Cities	(S)	3/12/02	479
" " "	(S)	5/21/02	549
AMA002 Sutter Creek @ HWY49	(F)	10/24/02	1733
" " "	(F)	11/7/02	>2420
" " "	(S)	12/10/02	613
SJC513 Calaveras @ HWY 88	(S)	3/11/02	>2420

(S) = storm event
(F) = flushing storm after dry creek bed

Further assessment utilizing USEPA guidelines is delineated in Table 11. identifies whether a sample collected at a specific site met USEPA guidelines for contact recreation. From the table, it appears that the majority of elevated E. coli concentrations occur outside of typical recreational swim period (May 1 to October 1). The exceptions would be the Consumnes River @ HWY 49, Gold Beach and Twin Cities and the Calaveras River @ HWY 88 during a May storm event as well as the Cosumnes at Michigan Bar and Calaveras @ HWY 88 during August.

Table 11 Comparison of Bacteria Results to Environmental Protection Agency E. coli (MPN) Guidelines for Contact Recreation

Site Code	Site Description	Month																							
		Mar		Apr			May			Jun			Jul	Aug		Sep			Oct		Nov		Dec		
Cosumnes Watershed																									
ELD001	Jenkinson Lake @ Pinecone CG				X				X		X		X					X						X	
ELD002	Jenkinson Lake @ Mormon Emigrant				X				X		X		X					X						X	
ELD003	Cosumnes River @ Gold Beach Park				X				X		X		X					X						X	
ELD004	Cosumnes River @ Highway 49				X				X		X		X					X						X	
SAC003	Cosumnes River @ Michigan Bar Rd.				X				X		X		X					X						X	
SAC001	Cosumnes River @ Twin Cities Rd.												D	D	D	D	D	D	D	D	D	D			
Mokelumne Watershed																									
AMA001	N. Fork Mokelumne River @ Hwy 26				X				X		X		X					X						X	
AMA002	Sutter Creek @ Highway 49				X				X		X		X			D	D	D	D					X	
CAL004	Mokelumne River @ Highway 49				X				X		X		X					X						X	
AMA003	Lake Amador @ Boat Launch				X				X		X		X					X						X	
CAL005	Camanche Reservoir @ South Shore				X				X		X		X					X						X	
SJC512	Mokelumne River @ Van Assen				X				X		X		X					X						X	
SAC002	Mokelumne River @ New Hope Road				X				X		X													X	
Calaveras Watershed																									
CAL001	San Antonio Crk. @ Sheep Ranch Rd.				X				X		X		X					X						X	
CAL002	Calaveritas Creek @ Highway 49				X				X		X		X	D	D	D	D	D	D					X	
CAL003	N. Fk. Calaveras River @ Gold Strike				X				X		X		X	D	D	D	D	D	D	D	D	D		X	
CAL006	New Hogan Res. @ Acorn East CG				X				X		X		X					X						X	
CAL007	New Hogan Reservoir @ Wrinkle Cove				X				X		X		X					X						X	
CAL008	Calaveras River @ Monte Vista				X				X		X		X					X						X	
SJC513	Calaveras River @ Highway 88				X				X		X		X					X			D	D	D	D	D

X Not Sampled | D Dry | <235 MPN | 236-298 MPN | 299-409 MPN | 410-575 MPN | >575 MPN